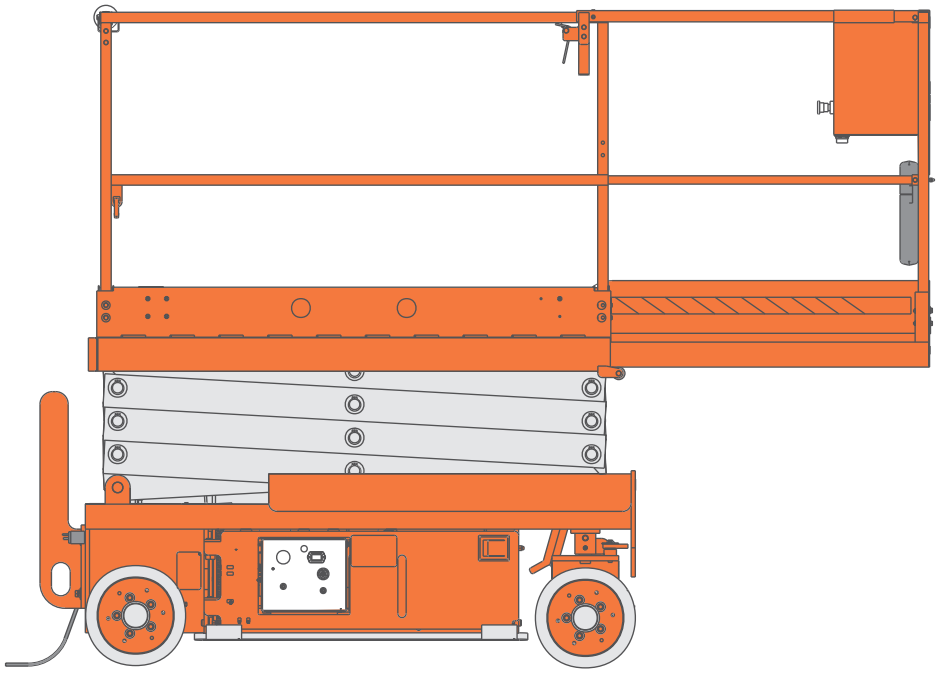
Maintenance Manual



S1930

P/N 0361270
February, 2001

Snorkel

DANGER

The aerial platform is not electrically insulated. Death or serious injury can result from contact with, or inadequate clearance from, an energized conductor.

Do not go closer than the minimum safe approach distance as defined by the Minimum Safe Approach Distance section in Chapter 1–Safety.

Regard all conductors as energized.

Allow for electrical wire sag and aerial platform sway.

If the platform, scissors structure, or any part of the aerial platform contacts a high-voltage electrical conductor, the entire machine can become electrically charged.

If that happens, remain on the machine and do not contact any other structure or object. This includes the ground, adjacent buildings, poles, and any other objects that are not part of the aerial platform.

Such contact could make your body a conductor to the other object, creating an electrical shock hazard resulting in death or serious injury.

If an aerial platform is in contact with an energized conductor the platform operator must warn ground personnel in the vicinity to stay away. Their bodies can conduct electricity creating an electrical shock hazard resulting in death or serious injury.

Do not approach or leave the aerial platform until the electricity has been turned off.

Do not attempt to operate the lower controls when the platform, scissors structure, or any part of the aerial platform is in contact with a high-voltage electrical conductor or if there is an immediate danger of such contact.

Personnel on or near an aerial platform must be continuously aware of electrical hazards, recognizing that death or serious injury can result from contact with an energized conductor.

CALIFORNIA

Proposition 65 Warning

Battery posts, terminals and related accessories contain lead and lead components, chemicals known to the State of California to cause cancer and birth defects or other reproductive harm. Wash hands after handling.

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Chapter 1. Safety

Introduction

This maintenance, service, and repair manual will provide proper procedures that are essential for safe and reliable operation of the Snorkel S1930 Scissor Lift. The outlined procedures should be performed as recommended to insure operator safety and vehicle integrity.

Disclaimer of Liability

This manual has been prepared by Snorkel International, Inc. for reference and use by service personnel who have been trained to properly repair and service Snorkel aerial platforms. Snorkel International, Inc. has exercised reasonable care and diligence to present accurate, clear, and complete information and instructions regarding the techniques required. It is the responsibility of the service personnel to: (a) routinely inspect the machine for wear and damage, (b) perform maintenance following the recommended schedules and procedures, (c) perform necessary repairs following outlined safety procedures, and (d) following any service or repair, to fully inspect and test the machine insuring that the work has been correctly performed and that the machine is functioning properly.

Snorkel International, Inc. will not be liable for unauthorized alterations or modifications to the machine. Nor shall it be liable for improper or abusive operation. No alteration or modification of the machine that, in any way, may affect its structural integrity, stability, and/or safe use shall be performed without specific written approval from Snorkel International, Inc.

Unauthorized alterations or modifications will void the warranty and may adversely affect the machine's performance, endangering personnel and/or property. Snorkel International, Inc. will not be responsible for unauthorized alterations or modifications that cause death, personal injury, and/or property damage.

Safety

For maximum safety it is essential that all personnel active in the care or maintenance of this machine read and understand this manual. Additionally, all maintenance personnel must be trained and qualified to operate the machine.

Safe use requires constant vigilance. Safety alerts throughout the manual highlight situations in which accidents can occur. These alerts require special attention.

When performing maintenance or service work on the machine, be sure to wear safety glasses, shoes and all appropriate protective clothing and equipment. Be careful of rings, jewelry, loose clothing, or long hair that may become caught in machinery or pinch points.

When a service procedure requires manual lifting, use proper lifting techniques.

The potential for serious injury or damage is greatly reduced by reading and following the procedures and guidelines in this manual.

Do Not Perform Maintenance Unless:

1. You are trained and qualified to operate and perform maintenance on this machine.
2. You have read, understand, and obey:
   - manufacturer's instructions and safety rules
   - your employer's safety rules
   - all applicable governmental regulations
3. You have the appropriate tools, lifting equipment, and suitable workshop.

The information in this manual does not replace any safety rules that apply to your local area. Before operating this machine it is essential the operator is fully in compliance with local laws and regulations.

Safety Alerts

A safety alert symbol is used throughout this manual to indicate danger and caution instructions. Follow these instructions to reduce the likelihood of personal injury and property damage. The terms danger and caution indicate varying degrees of personal injury or property damage that can result if the instruction is not followed.

⚠DANGER

I**ndicates a situation which if not avoided can result in death or serious injury**.

⚠ CAUTION

Indicates a situation which if not avoided can result in minor injury or property damage.

Notes

Notes are used to provide special information or helpful hints to assist in aerial platform service or repair, but do not indicate a hazardous situation.

Supporting/Lifting Devices

The weight capacity of all supporting/lifting devices including, but not limited to, overhead hoists, lifts, chains, straps, jacks, or jack stands must be checked for suitability of use; that their weight capacity is not exceeded.

Electrocution Hazards

The aerial platform is made of metal components and is not insulated. Regard all conductors as energized. If for transport the machine must be outdoors, do not operate during a thunderstorm.

Minimum Safe Approach Distance

Minimum safe approach distances to energized power lines and their associated parts must be observed while operating the aerial platform.

⚠DANGER

The aerial platform is not electrically insulated. Death or serious injury can result from contact with, or inadequate clearance from, an energized conductor. Do not go closer than the minimum safe approach distance as defined by ANSI.

ANSI publications define minimum distances that must be observed when working near bus bars and energized power lines. Table 1 and Figure 3 are reprinted courtesy of Scaffold Industry Association, ANSI/SIA A92.6, page 36.

Voltage range (phase to phase)	Minimum safe approach distance	
	(Feet)	(Meters)
0 to 300V	Avoid contact	
Over 300V to 50kV	10	3.05
Over 50kV to 200kV	15	4.60
Over 200kV to 350kV	20	6.10
Over 350kV to 500kV	25	7.62
Over 500kV to 750kV	35	10.67
Over 750kV to 1000kV	45	13.72

Table 1—Minimum Safe Approach Distance

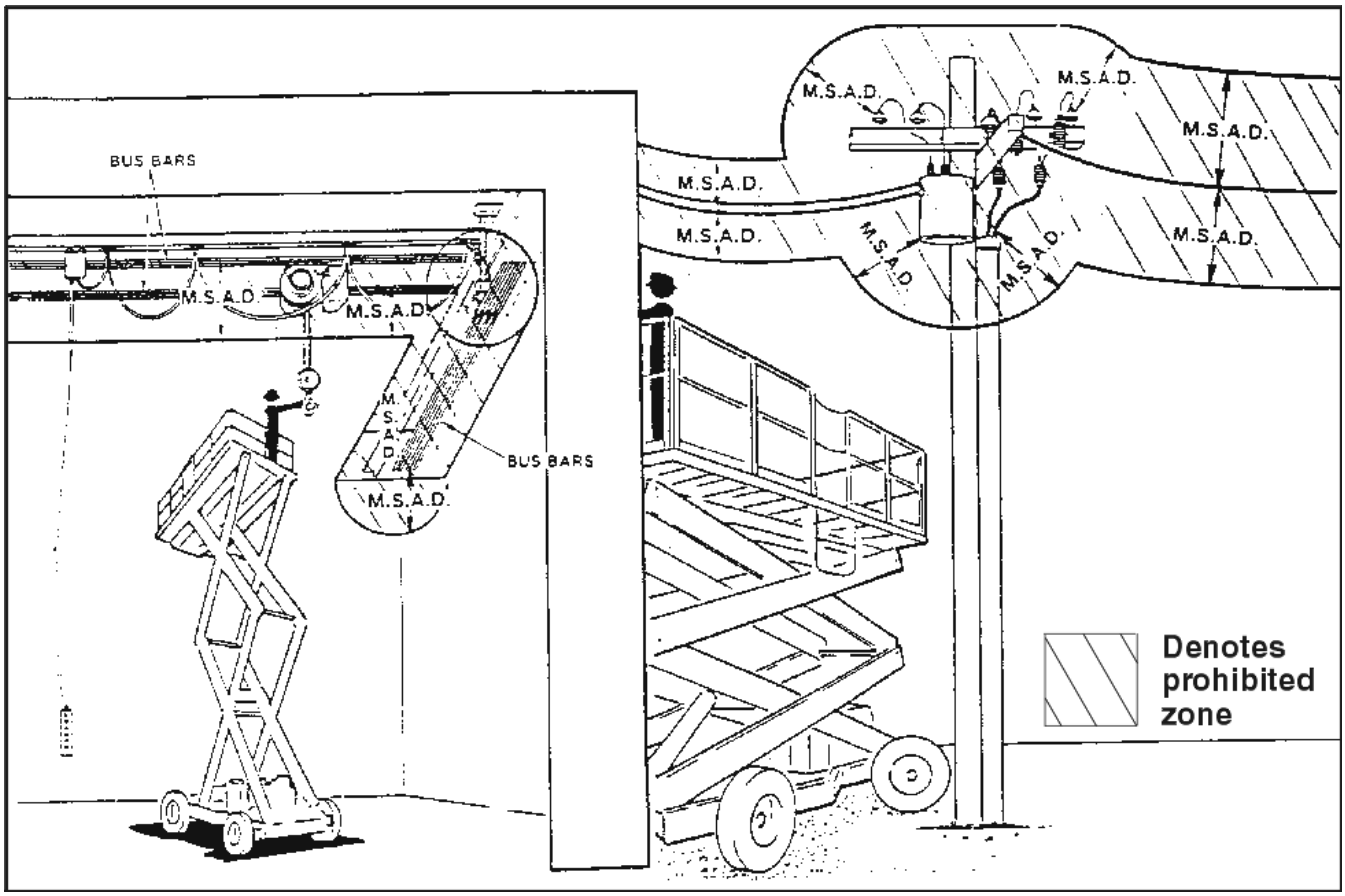
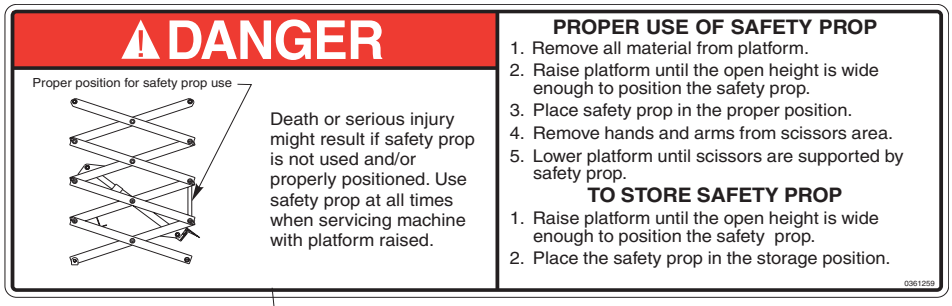
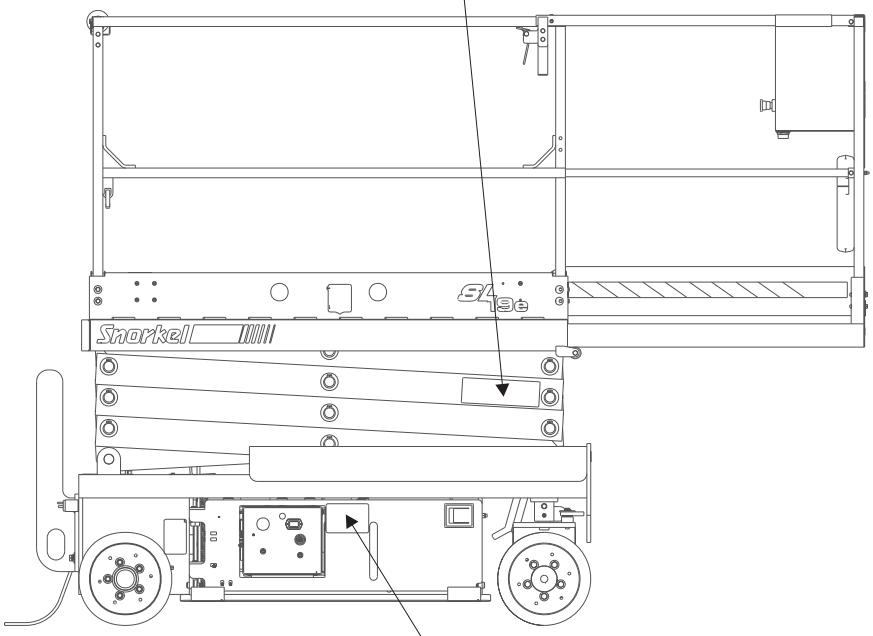


Figure 3—Minimum Safe Approach Distance

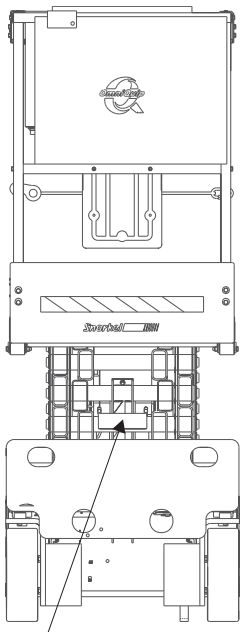
Safety Related Placards and Decals

The aerial platform is equipped with placards and decals that provide instructions for equipment operation and accident prevention. Do not operate the machine if any placards or decals are damaged or illegible. Replacements are available through your Snorkel Dealer or directly from Snorkel International, Inc. Parts numbers for each are listed in the Repair Parts manual.

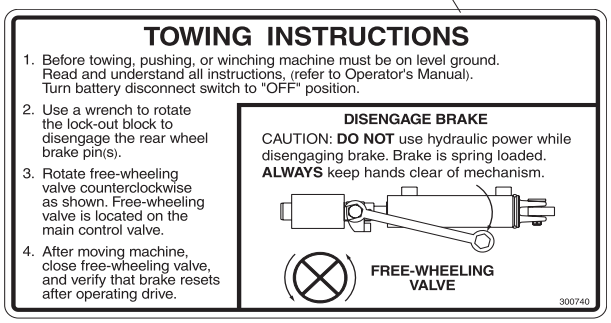


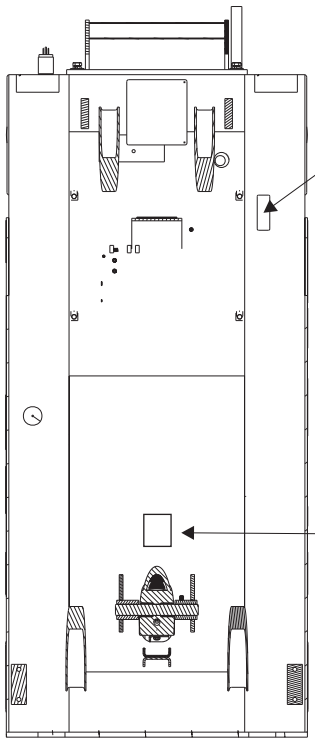


Right Side



Front





Chassis
Top View

DANGER

DO NOT ALTER OR DISABLE LIMIT SWITCHES, SAFETY SWITCHES, OR INTERLOCKS.

451986

Snorkel

MODEL NUMBER		SERIAL NUMBER	
MONTH / YEAR OF MANUFACTURE		SLOPE SENSOR ALARM SETTING	deg
MAXIMUM MACHINE WEIGHT	lbs kg	MAXIMUM WHEEL LOAD	lbs kg
ENGINE POWERED MODELS	hp kW	BATTERY POWERED MODELS ONLY — DRIVE MOTORS	V
		BATTERIES	V Ah
MAXIMUM ALLOWABLE MANUAL FORCE (SIDE PULL)	lbs N	MAXIMUM ALLOWABLE WIND SPEED	mi/h m/s
PLATFORM SIZE	in cm	MAXIMUM PLATFORM REACH	ft m
MAXIMUM PLATFORM HEIGHT	ft m	MAXIMUM DRIVE HEIGHT	ft m
RATED NUMBER OF OCCUPANTS		UNRESTRICTED PLATFORM CAPACITY	lbs kg

CAUTION

Do not remove any weight from this machine Any weight added must be distributed equally on each axle. Proper stability and axle weights of this machine are based on the platform size shown above.

Axle weights with machine in the stowed - travel position.

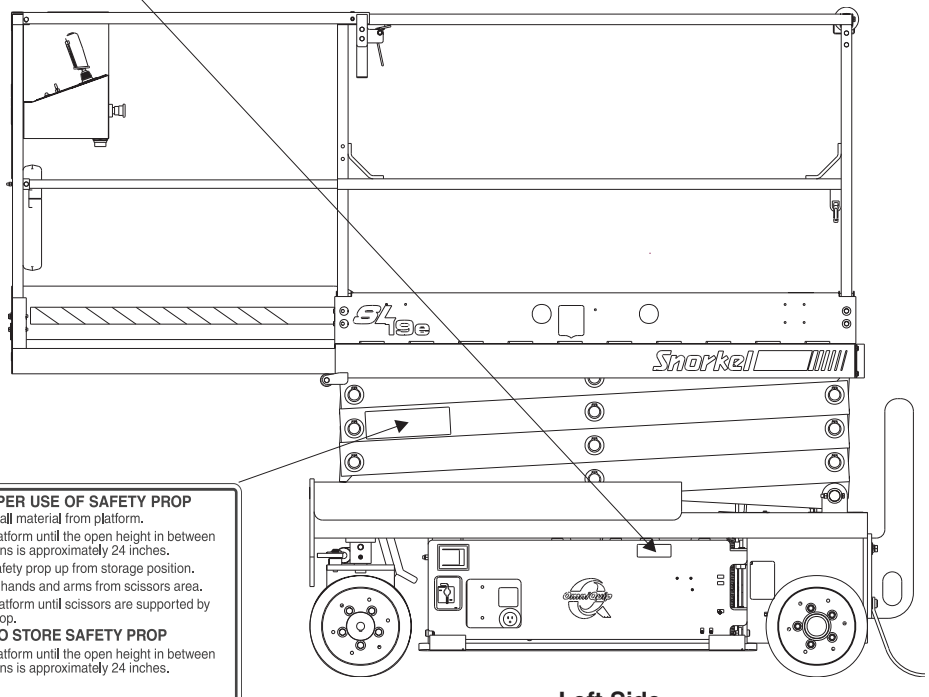
STEER AXLE	lbs	kg	
DRIVE AXLE	lbs	kg	

0070901

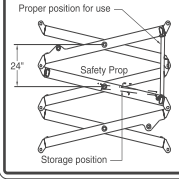
DANGER

TIPOVER HAZARD
DEATH OR SERIOUS INJURY MAY RESULT IF MACHINE TIPS OVER
Trays must be closed when platform is elevated.

300760



DANGER



Death or serious injury might result if safety prop is not used and/or properly positioned. Use safety prop at all times when servicing machine

PROPER USE OF SAFETY PROP

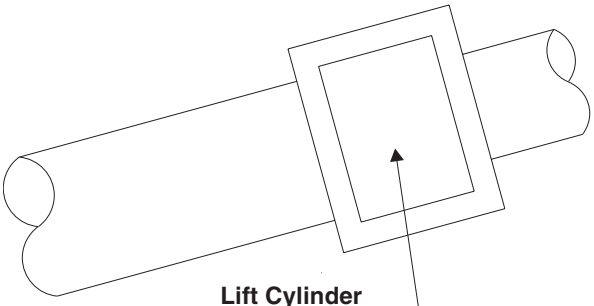
1. Remove all material from platform.
2. Raise platform until the open height in between center pins is approximately 24 inches.
3. Swing safety prop up from storage position.
4. Remove hands and arms from scissors area.
5. Lower platform until scissors are supported by safety prop.

TO STORE SAFETY PROP

1. Raise platform until the open height in between center pins is approximately 24 inches.

301476

Left Side



Lift Cylinder

⚠ DANGER

Using incorrect parts can cause cylinder failure. Death or serious injury can result.

Use only:

APPROVED Snorkel PARTS

0074311

⚠ DANGER

DEATH OR SERIOUS INJURY CAN RESULT FROM TIPPING OVER.
TO KEEP FROM TIPPING THIS MACHINE OVER FOLLOW THESE RULES.

DO NOT RAISE OR DRIVE AN ELEVATED PLATFORM ON A **SLOPE**

DO NOT RAISE OR DRIVE AN ELEVATED PLATFORM ON **SOFT OR UNEVEN SURFACES**

GO NO CLOSER THAN 4 feet (1.2m) to ***ANY*** **DROP OFF OR HOLE**

4 FT

DO NOT RAISE THE PLATFORM OUTDOORS OR IN THE WIND

FOR INDOOR ELEVATION ONLY

OTHER ACTIONS CAN ALSO CAUSE THIS MACHINE TO TIP OVER

DO NOT override safety devices.

DO NOT overload the machine.

DO NOT stand or sit on guardrails.

DO NOT attach ropes or chains to guardrails.

DO NOT carry loads outside the railing or use as a crane.

DO NOT ride platform while machine is on a truck, fork lift or other device.

DO NOT use ladder, scaffold, or other means to increase size or platform height.

DO NOT use with improperly inflated or damaged tires or wheels.

ALARM MEANS TIPOVER DANGER!
LOWER PLATFORM IMMEDIATELY
1. 2. 3. OK

OK

TO AVOID TIPOVER HAZARDS **USE ON FLAT, LEVEL, AND SOLID SURFACES ONLY**

4 FT

ELECTRICAL SHOCK CAN KILL YOU

This machine is not electrically insulated. Maintain 10 feet minimum clearance from electrical power lines and apparatus.

This machine will not protect you from shock.

Allow for platform sway, rock, or sag. If voltage is 300 V to 50 kV stay at least 10 feet (3.1m) away. If voltage is more than 50 kV talk with your supervisor or read the Operator's Manual on this machine for safe distances.

DO NOT use this machine without the railings and the entry gate, chain or bar in place. You could fall out and hurt or kill yourself.

DO NOT use this machine if it is not working right, or if any part of it is damaged, worn, or missing. An accident could cause injury or death.

DO NOT let an untrained or unauthorized person use this machine. When you leave the machine unattended, remove the key, or turn off the battery switch on the base of the machine and lock the battery switch in the off position.

DO NOT replace components critical to machine stability, such as batteries and wheel equipment, with lighter weight or non-factory approved substitutes.

NOTE: STUDY THE OPERATOR'S MANUAL BEFORE OPERATING THIS MACHINE.

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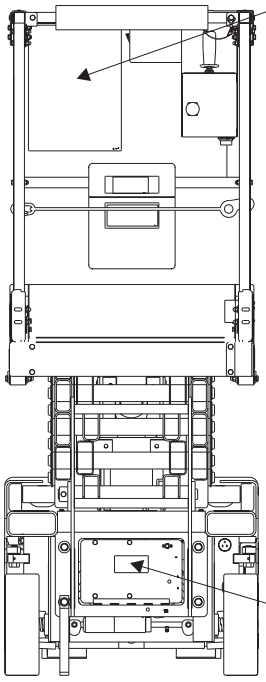


Rear

⚠ CAUTION

THIS CYLINDER IS SPRING LOADED. INCORRECT ASSEMBLY OR DISASSEMBLY COULD CAUSE PHYSICAL INJURY. BEFORE REMOVING SNAP RING, RETRACT CYLINDER ROD .25 INCH. REMOVE SNAP RING AND SLOWLY EXTEND CYLINDER ROD UNTIL SPRING PRESSURE IS RELEASED. ASSEMBLE IN REVERSE ORDER.

475596

Chapter 2. Specifications

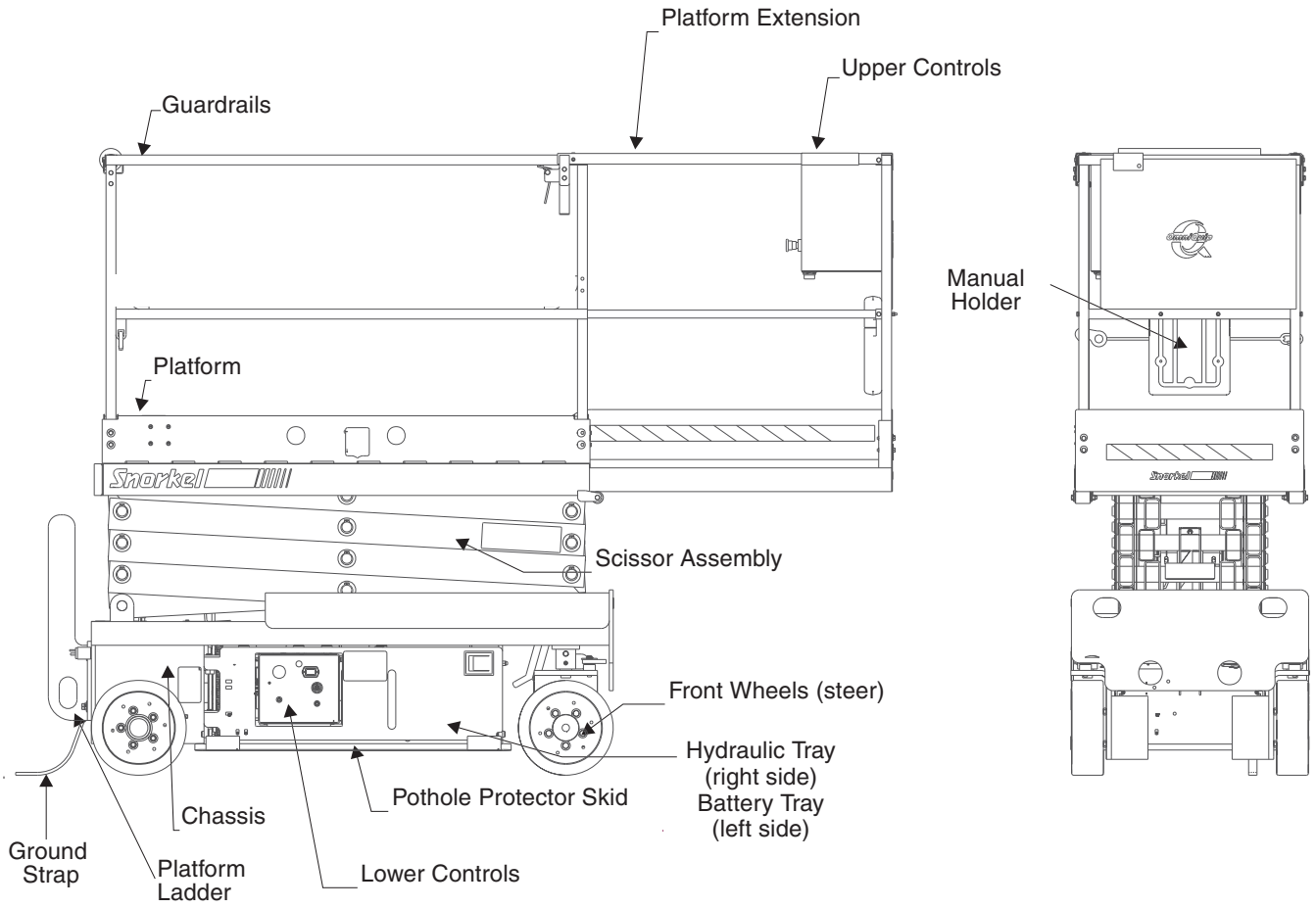
This Snorkel aerial platform has been manufactured to conform to all applicable requirements of the following agencies:

- Occupational Safety and Health Administration (OSHA)
- American National Standards Institute (ANSI)
- European Standard prEN 280
- Canadian Standards Association (CSA)

This machine has been designed and manufactured for interior use only. Operate only on a firm, flat, level surface capable of withstanding all load forces (see general specifications for wheel load, floor pressure, and drive/lift level sensor interlock).

Component Identification:

S1930
Scissor Lift



The serial number placard is located inside the hydraulic tray, at the front end of the chassis.

S1930 Scissor Lift

General Specifications

Maximum platform height	19′ (5.8 m)
Maximum working height	25′ (7.6 m)
Weight, GVW approximate	3,040 lb (1,379 kg)
Stowed width	30″ (76.2 cm)
Stowed length	74″ (188.0 cm) or 66″ (167.6 cm) minus platform ladder
Stowed height	79″ (200.6 cm)
Rated work load Main deck Deck extension	 500 lb (227 kg) or two people 250 lb (113 kg) or one person
Platform size Main deck Deck extension Guardrail height Toeboard height	 29″ X 61.5″ (74 cm X 156 cm) 24″ X 36″ (61.0 cm X 91.4 cm) 39″ (1.0 m) 6″ (15.2 cm)
Maximum number of occupants	2 people
Gradeability	20%
Turning radius Inside Outside	 7.5″ (19.1 cm) maximum, 5″ (12.7 cm) minimum 65.5″ (166.4 cm) maximum, 64.5″ (163.8 cm) minimum
Tire size	4″ X 12″ (10.2 cm X 30.5 cm)
Drive/Lift Level Sensor Interlock	2° (side-to-side), 4° (front-to-rear)
Ground clearance Pothole skid up Pothole skid down	 2 1/2″ (6.35 cm) 3/4″ (1.90 cm)
Travel speed Platform lower than 7′ (2.1 m) Platform higher than 7′ (2.1 m)	 2 mph (3.2 km/h) maximum 0.4 mph (.64 km/h) maximum
Platform function speed Raise Lower	 12 to 20 seconds 20 to 26 seconds
Wheelbase	54″ (137.2 cm)
Batteries Recommended electrolyte	24 V DC, 220 amp/hr Distilled water
AC outlet (on platform)	120 V, 17.4 amp
Fuse (in lower control box)	20 amp AGC type Buss fuse (1/4″ X 1 1/4″)
Recommended hydraulic fluid	Mobil DTE-13M (ISO VG32): above 10°F (-13°C) Mobil DTE-11M (ISO VG15): below 10°F (-13°C)
Hydraulic system pressure	2,800 psi (19,305 kPa)
Maximum fluid operating temperature	160°F (71°C)
Hydraulic fluid reservoir capacity	3 US gal. (11.4 liter)
Hydraulic system capacity	3.5 US gal. (13.2 liter)

Ambient air temperature operating range	0° F to 110° F (Fahrenheit), -18° C to 43° C (Celsius)
Drive system	Front two-wheel drive
Maximum wheel load	1,416 lb (642 kg)
Maximum floor pressure	175 psi (12.3 kg/cm²)
Vibration	Less than 2.5 m/s²
Sound level	Below 70 dB(A)
Warranty	Five-year

Chapter 3. Maintenance

Service Guidelines

This manual provides information necessary to service and maintain the aerial platform. The procedures and techniques described have been carefully designed for safety and efficiency. Following them will ensure correct installation and smooth operation of all machine components and systems.

Many of the machine's components are bulky and heavy and will require the aid of mechanical devices if they are to be moved. Always be mindful of your human limitations; use correct lifting techniques. Do not allow heavy parts to rest in an unstable position; be sure they are supported safely and securely.

All service work on the machine should be done with the platform fully stowed, unless the work requires access under the platform. In that case, be sure the safety prop is securely positioned before beginning work.

Cleaning

Dirt and foreign matter are enemies to fight against. They can and will seriously shorten the service life of vital components. The machine has many built-in safeguards to protect against contaminates. Seals, gaskets, and filters are provided to keep components and hydraulic fluid clean. However, it is necessary that they be serviced following the schedules outlined in this manual. Make every attempt to keep the service area as clean as possible.

Prior to disconnecting any hydraulic lines, be sure to wipe clean the connection area. Immediately after disconnecting, clean all openings and fittings then cap or cover all openings to avoid contamination.

Keep all new parts in their packages until ready for immediate installation. All removed parts should be cleaned and kept covered. Prior to reassembly, inspect all parts for contamination.

Replacement Components

Use only Snorkel approved replacement parts and components for service or repair of the machine. Parts are available from OmniQuip Parts WorldWide. See the Parts Manual for part numbers and ordering information.

Component Removal and Installation

Many of the heavier components will require mechanical assistance for removal. All slings, chains, cables, etc. should be parallel to each other and as near perpendicular to the top of the part being lifted as possible.

If it is necessary to lift a component at an angle, be aware that the weight capacity of an eyebolt or similar bracket lessens as the angle between the supporting lift and the lifted component becomes less than 90°.

If a part resists removal, verify that all nuts, bolts, cables, brackets, or wiring have been removed and that no adjacent parts are interfering.

Component Disassembly and Reassembly

Prior to disassembling a component, be sure you have read and understand the recommended procedure guidelines. The steps should be completed as described. Do not partially disassemble one part then start on another. Always recheck completed steps to assure nothing has been overlooked.

Replace all used o-rings, seals, and gaskets with new prior to reassembly. Dip all rings and seals in hydraulic fluid prior to reassembling . Replace any part having imperfect threads.

Bearings

Upon removal, carefully examine all bearings. Discard and replace any that are pitted, scored, or burned. All serviceable bearings should be cleaned with a nonflammable cleaning solvent and allowed to air or drip dry. Compressed air may also be used but avoid allowing the bearing to spin. When dry, coat them lightly in oil and wrap them in waxed paper, preventing contamination, until ready to be installed.

Make sure all bearings to be installed are freshly lubricated. When pressing the bearing into a retainer or bore apply pressure to the outer race. If bearing is to be installed onto a shaft, apply pressure to the inner race.

Gaskets

If gaskets are to be custom fabricated, make sure the gasket material is of equivalent material and thickness to the original. All holes must be cut accurately. Make sure the installation alignment is accurate. Improperly installed gaskets can cause serious system damage.

Bolts

All replacement bolts must have the same SAE hardness rating as the original. Using the proper length is also very important. A bolt too long will bottom before the head is snugged tightly. A bolt too short will not engage sufficient thread to hold properly.

Hydraulic System

It is important to keep the hydraulic system clean. If evidence of contamination (such as metal or rubber particles) is found, the system should be drained and flushed (see Chapter 7). Before disconnecting, wipe clean all hose connections. Make sure the work surface

is clean during any assembly process. Thoroughly clean and lubricate all parts prior to reassembly.

Parts should be inspected prior to reassembly. Burrs, nicks, or scratches may be removed by honing with #600 crocus cloth, followed by a thorough clean and dry. If this does not restore the part to serviceable condition, replace the part. Do not alter the contour of any part.

Prior to disconnecting any hydraulic hose, make sure the part is sufficiently blocked or the weight is removed from the cylinder by a lifting device.

Mark or tag all hydraulic lines and their receptacles prior to disconnection. This will facilitate the reconnecting process. This tagging procedure will also aid in electrical wiring maintenance.

Return Filter

The hydraulic fluid return filter (figure 3. 1) is mounted in the right-hand tray next to the hydraulic fluid reservoir. The filter element is a throw-away type (the part number is in the Parts Manual) and should be changed after the initial break-in period (approximately 50 hours of operation). Thereafter it should be changed as part of every 90-day maintenance procedure (more often if in a dirty environment).

During filter change, examine the interior of the filter housing for deposits of metal particles. If present, they are a sign of excessive wear in one or more of the system components.

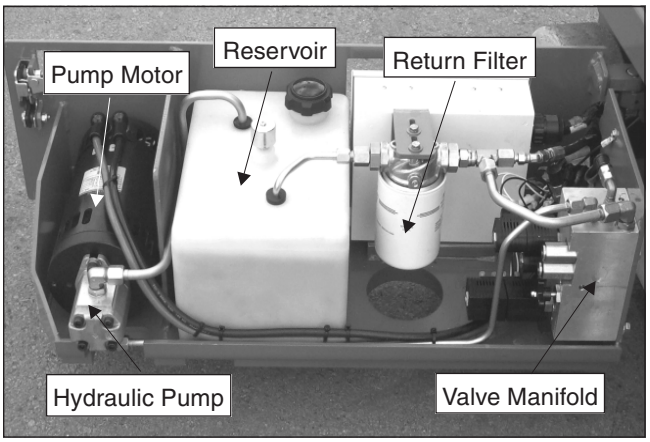


Figure 3.1—Hydraulic Tray

Hydraulic Fluid Reservoir

Before checking the fluid level, all hydraulic cylinders should be fully retracted and the platform in stowed position. If the level is low, add fluid until it reaches the indicator line on the side of the reservoir (figure 3.1).

As part of the annual maintenance, the reservoir should be emptied and cleaned, along with the filler cap, with kerosene, fuel oil, or similar solvent. Then re-install and fill with new fluid.

Batteries

Fully recharge the batteries immediately after use. One charging cycle per day is preferred.

The battery terminals should be periodically cleaned using a non-metallic brush and a solution of baking soda and water. Remove the cables, then clean and dry the terminal posts. Coat them with an anticorrosion compound before reattaching the cables.

⚠DANGER

Batteries give off hydrogen and oxygen that can combine explosively. Death or serious injury can result from a chemical explosion. Do not smoke or permit open flames or sparks when servicing the batteries.

Battery acid can damage the skin and eyes. Serious infection or reaction can result if medical treatment is not given immediately. Wear face and eye protection when working near batteries.

Batteries contain sulfuric acid that can damage your eyes or skin on contact. Wear a face shield, rubber gloves, and protective clothing when working around batteries. If acid contacts your eyes, flush immediately with clear water and get medical attention. If acid contacts your skin, wash off immediately with clear water.

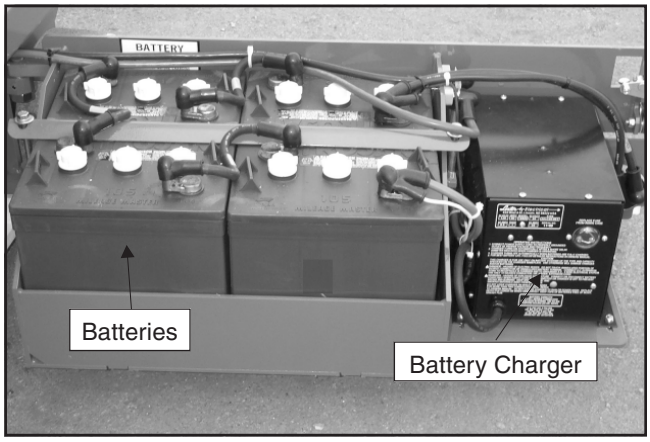


Figure 3.2—Battery Tray

The batteries (figure 3.2) are enclosed in a tray located on the left side of the machine. For access, park the unit on a hard, level surface, lower and stow the platform, then unlatch and open the tray.

Check cell specific gravity during each routine maintenance. First remove all vent caps from the battery. Check each cell with a hydrometer. The reading should be 1,260 or greater. If the electrolyte of any cell is low, add distilled water to a level 1/4″ below the bottom of the fill tube.

During battery maintenance, remove jewelry such as watches, necklaces, rings, or bracelets. They can short circuit and cause severe burns.

Look for loose or corroded connections. Clean them with electrical contact cleaner or fine sandpaper.

Cold weather can cause problems. Batteries discharge at only 70% of capacity at freezing temperature. The ideal operating temperature is 68°F+ (20°C). Batteries should not be left in a cold environment for an extended period. They can discharge, freeze, and crack within two to three weeks of non-use in cold weather.

Battery Maintenance

The following information about battery care and maintenance was supplied by Interstate Batteries, Inc. and is reprinted here with their permission.

New batteries need to be cycled several times before reaching full capacity (5-40 cycles, depending on type). Usage should be limited during this period.

Always fully recharge batteries immediately after use. Batteries perform best when they are fully charged. This practice will insure more capacity and longer life.

The deeper the discharge, the fewer number of cycles a lead-acid battery will deliver. Deep discharges deteriorate the battery quicker than light shallow cycles.

Battery cables should, at all times, be intact and connectors kept tight. Systematic inspection is recommended.

Vent caps should be kept in place and tight during vehicle operation and battery charging.

Batteries should, at all times, be kept clean; free of dirt and corrosion. Always keep the top of batteries clean. A film on top of the battery can cause the current to migrate between the posts, accelerating self-discharge.

Never let the electrolyte level of a lead-acid battery fall below the plates. Failure to maintain the electrolyte at proper levels causes damage to the exposed plates reducing charge capacity.

Always check electrolyte level before charging. Add distilled water to a level 1/8″ above plates only if they are found to be exposed. Re-check electrolyte level after charging. Add distilled water to a level 1/4″ below the bottom of the fill tube in the cell cover.

Water used to replenish batteries should be distilled or treated to not exceed 200 TDS (total dissolved solids) parts per million. Particular care should be taken to avoid metallic solids (iron).

A fully charged battery will give you the best and longest service. Be sure the batteries are fully charged before testing or using. A fully charged battery, without a drain or load, after the surface charge has dissipated, is 6.35 volts for a 6 volt battery.

- 6.30 volts: 93% charged
- 6.27 volts: 89% charged
- 6.22 volts: 80% charged
- 6.10 volts: 50% charged
- 5.94 volts: 20% charged

Batteries should not be discharged below 20% of capacity (approximately 1.8 volts per cell under normal operating load, 1.98 volts open circuit, 1.145 specific gravity). Proper battery sizing will help avoid excessive discharge.

Battery chargers should be sized to fully charge batteries in an eight-hour period. Chargers should be kept in proper operating condition.

Do not use a mismatched charger of any type (i.e., a 12 volt charger on a 24 volt pack). An undersized charger will never complete the job, no matter how long it tries. An oversized charger will cause excess gassing and heat, possibly resulting in a battery meltdown and/or explosion.

Never charge a lead-acid battery with a sealed (gel cell) battery charger. The lead-acid battery needs higher voltage to finish its charge. Without it, the battery will never fully re-charge and sulfation can occur.

Always allow batteries to cool after charging. The cooling time is very important because heat is generated during the recharge and discharge cycles. Without sufficient cooling, heat increases, accelerating grid corrosion, one of the major causes of battery failure.

Deep cycle batteries need to be equalized periodically. Equalizing is an extended, low-current charge performed after the normal charge cycle. It helps keep cells in balance. Actively used batteries should be equalized once a week. Manually timed chargers should have the charge time extended approximately three hours. Automatically controlled chargers should be unplugged and reconnected after completing a charge cycle.

In situations where multiple batteries are connected in series, parallel, or series-parallel, a replacement battery should be of the same size, age, and usage level as the companion batteries. Do not put a new battery in a pack that has 50 or more cycles. Either replace all the batteries with new batteries or install a good used battery in place of the bad. New batteries should be given a full charge before use.

Periodic battery testing is an important preventative maintenance procedure. Using a hydrometer, check the specific gravity of each cell. It should be 1,260 or greater. Checking each cell (fully charged) will give an indication of balance and true charge level. Imbalance could mean the need for equalizing and is often a sign of improper charging or a bad cell. Voltage checks (open circuit, charged and discharged) can locate a bad cell or weak battery. Load testing will pick out a bad cell when other methods fail. Be on the look-out for abnormal cells. A weak cell will cause premature failure of companion cells or the entire battery.

As batteries age, their maintenance requirements change. Generally their specific gravity is higher and gassing voltage goes up. This means longer charging

time and/or higher finish rate (higher amperage at the end of the charge). Usually, older batteries need to be watered more often and their capacity decreases.

"Opportunity charging", a short partial charge during an extended duty cycle, is a controversial subject. Generally, the practice is a "crutch" to make up for undersized batteries. The correct approach is to install adequate battery capacity. If this is impossible because of lack of space in the battery compartment or extreme operating conditions (24 hour intermittent use, for example), "opportunity charging" is better than excessive battery discharging. However, the practice can cause batteries to overheat, require more water, and usually shorten battery life. "Opportunity charging" is a trade-off, something to avoid, if possible. One charging cycle per day is preferable.

Extreme temperatures can substantially affect battery performance and charging. Cold reduces battery capacity and retards charging. Heat increases water usage and can result in overcharging. Very high temperature can cause "thermal run-away" which may lead to an explosion or fire. If extreme temperature is an unavoidable part of an application, consult a battery charger specialist about ways to deal with the problem.

An overly discharged battery might need to be cycled a few times before it can fully recover. If a battery begins to heat before coming up to a full charge, it might be necessary to discharge the battery and recharge it a few times. The charge and discharge cycle may improve its ability to accept a charge and facilitate its recovery to usable condition.

Inactivity can be harmful to deep cycle batteries. If they sit for several months, a "boost" charge should be given, more frequently in a warm climate (once a month) than in cold (every 2-3 months).

Never store a battery in a discharged state. The sulfate that forms during discharge may make the battery impossible to fully recharge.

Long-Term Storage

Prior to long-term storage of the machine, insure the batteries are fully charged. After storage, the batteries should be fully cycled prior to operation of the machine. Place the batteries under load to drain them followed by a full recharge cycle.

Battery Charger

The machine is equipped with an onboard automatic battery charger (figure 3.2). It contains an electronic circuit that, when plugged into a 115 V, 60 Hz electrical outlet, will completely recharge the batteries and automatically turn off at the end of the charge cycle. The battery switch (figure 6.1, Chapter 6) should be in the off position.

Note: All extension cords should be 3 conductor, 14 gauge, or larger, and of the shortest length possible.

⚠DANGER

Batteries give off hydrogen and oxygen that can combine explosively. Death or serious injury can result from a chemical explosion. Do not smoke or permit open flames or sparks when servicing the batteries.

The charging cycle may last 1 1/2 to 16 hours depending on the existing state of charge. If the charge cycle exceeds 16 hours, the charger should be shut off and the battery condition and specific gravity checked.

If the check reveals no problems, the charger should be checked.

- Always check electrolyte level prior to charging**.**
- Operate charger according to instructions outlined in this manual**.**
- Battery switch in off position.
- Do not smoke or introduce a flame or spark in the charging area**.**

Pothole Protection Interlock Test

The pothole protection interlock is a safety feature designed to prevent tip-over.

⚠DANGER

The machine may tip over if the pothole protection interlock does not operate properly. Death or serious injury can result from a tip-over accident. The interlock must be repaired or adjusted by a trained service technician before the machine can be safely used.

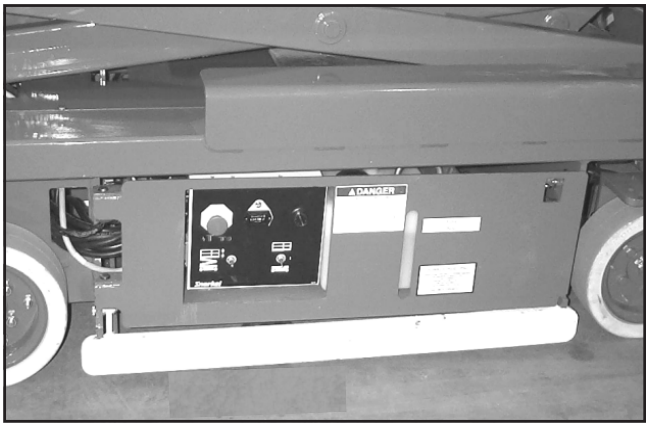


Figure 3.3—Pothole Protector Skid (lowered)

1. Park the machine on a flat, level slab.
2. Remove all persons and material from platform.
3. With platform fully lowered and swing-out trays closed, check ground clearance under pothole protector skids. Clearance should be 2 1/2″ or more on both sides of the unit (skids in retracted position).

4. Using lower controls, raise the platform while watching the movement of the pothole protector skids (figure 3.3). They should lower to approximately 3/4″ clearance and lock into place when the platform floor reaches 6 feet.
5. Watching the skids, fully lower the platform. They should raise to their original retracted position (2 1/2″ clearance).
6. Place a 1 1/2″ thick board (standard 2x4 lumber) under the right side skid to prevent it from fully lowering (figure 3.4).

Figure 3.4—Pothole Interlock Test

7. Using the lower controls, raise the platform while watching the skids. When the board prevents the skid from fully lowering, the interlock system should halt the platform at 6 feet or less and sound an alarm. Any attempts to further raise the platform should reactivate the alarm and the platform should not move.
8. Repeat steps 6 and 7 for the left side.

Level Sensor Interlock Test

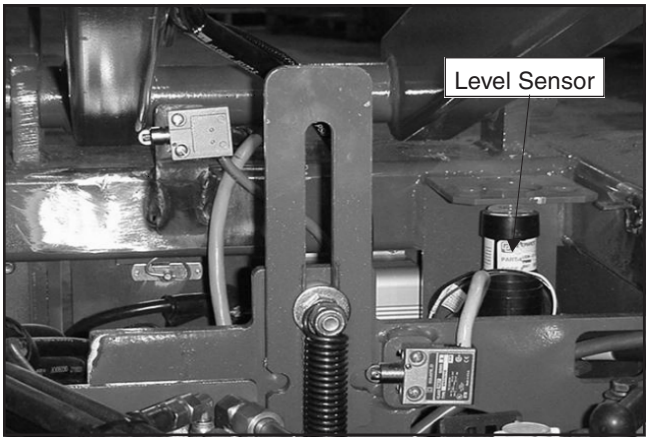


Figure 3.5—Level Sensor

The level sensor interlock is a safety feature designed to prevent a tip-over hazard. It will measure the tilt of the machine and protect against raising the platform at a dangerous angle. Routine testing of its operation is essential for safety.

⚠DANGER

The machine may tip over if the level sensor interlock does not operate properly. Death or serious injury can result from a tip-over accident. The interlock must be repaired or adjusted by a trained service technician before the machine can be safely used.

1. Fully complete the pothole protection interlock test.
2. Lower platform to stowed position.
3. Remove all persons and material from platform.
4. Park the unit on a flat slab. Use a carpenter's level to insure the floor is level (within 1/8″ difference front to rear and 1/16″ difference side to side).
5. Using a sling and hoist or a floor jack, raise the front of the unit 4 1/4″.
6. Using the lower controls, raise the platform. As the floor approaches 6 feet, the level sensor interlock should halt the platform and sound an alarm. Any attempts to further raise the platform should reactivate the alarm and the platform should not move. Fully lower the platform.
7. Repeat steps 5 and 6 for the rear.
8. Elevate the right side 3/4″.
9. Using the lower controls, raise the platform. It should raise smoothly to its full height, with no alarm. Fully lower the platform.
10. Elevate the right side to 1 1/4″.
11. Using the lower controls, raise the platform. As the floor approaches 6 feet, the level sensor interlock should halt the platform and sound an alarm. Fully lower the platform.
12. Repeat steps 8 through 11 for the left side.

Lubrication

Lubricants listed in this service manual should be used as specified. It is important that all lubricants meet or exceed OEM specs. If you contemplate using another, non-specified lubricant, please contact the Snorkel Customer Service Center for suitability evaluation.

Frequent Lubrication Points
(90 day or 150 hours)

- King pins (figure 3.6)
- Tray latches (figure 3.6) and hinges
- Pothole protection pivot points (figure 3.7)

King Pins and Latches

Use a grease gun to lubricate the king pins (figure 3.6). Wipe away any excess lubricant from exposed surfaces. Use powdered graphite to lubricate the tray latches(figure 3.6).

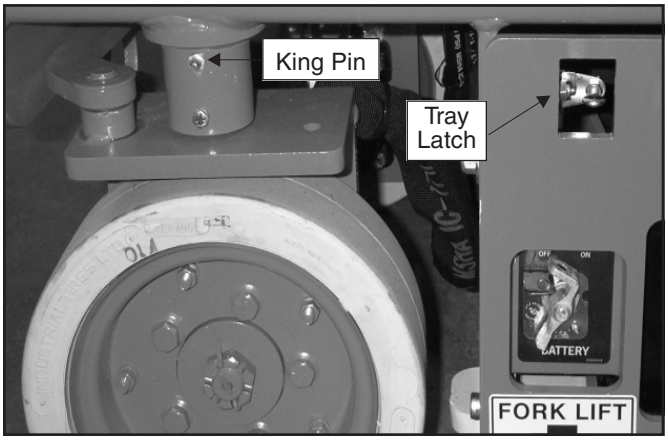


Figure 3.6—King Pin and Tray Latch

Pothole Protection Pivot Points

To access the pothole protection linkage pivot points (figure 3.7), fully open both trays. Use spray lubricant on each point. Make sure to lubricate the points at each end of the skid.

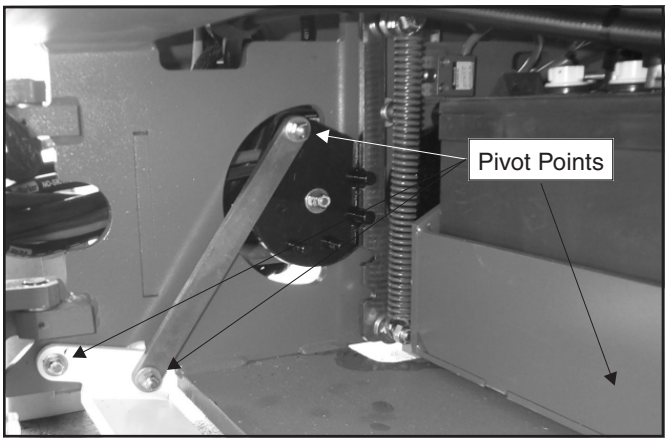


Figure 3.7—Pothole Protection Pivot Points

Preventive Maintenance

This manual provides preventative maintenance schedules designed to detect any defective, damaged or improperly secured parts and to provide timely guidelines for lubrication and other minor maintenance procedures. It is organized based on the frequency the procedures are recommended.

Maintenance Schedules

- Daily prestart inspection
- Frequent maintenance (every 90 days or 150 hours of operation)
- Annual maintenance (500 hours of operation)

⚠DANGER

Failure to perform maintenance following the recommended schedules may cause equipment failure resulting in death or serious injury. Do not operate a machine that has been found to be defective.

Maintenance routines require the use of checklists found in this chapter, which, after use, should be retained in a permanent file. Make additional copies for future use.

Daily Prestart Inspection

The prestart inspection and maintenance routine must be performed by a trained operator. It should be performed daily, prior to the first use of the machine.

Frequent Maintenance

The frequent maintenance routine must be performed every 90 days or after 150 hours of operation by a qualified person only.

Annual Maintenance

The annual maintenance routine must be performed annually or after 500 hours of operation by a qualified person only.

Prestart Inspection Checklist

Date:

Item	Inspect for	✔
Operator's manual	In manual holder	☐
Electrical system		
Battery fluid level	Proper level	☐
Battery terminals	Clean, connectors tight	☐
Battery charger	Proper operation	☐
Cables and wiring harness	No wear or physical damage	☐
Hydraulic system		
Fluid level	Between Full and Add marks	☐
Hoses, tubes, and fittings	No leaks	☐
Free-wheeling valve	Full closed	☐
Tires and wheels	Good condition	☐
Parking brakes	Proper cam operation	☐
Ground strap	In place and securely fastened	☐
Lower control station		
Operating controls	Proper operation	☐
Emergency stop	Shuts off lower controls	☐
Lowering alarm	Sounds when platform lowers	☐
Pothole protection interlock	Proper operation	☐
Level sensor interlock	Proper operation	☐
Emergency bleed-down valve	Proper operation	☐
Safety prop	No damage or deformation	☐
Flashing light (optional)	Proper operation	☐
Structures		
Weldments	Welds intact, no damage or deformation	☐
Slide blocks	Proper operation, no damage	☐
Fasteners	In place and tight	☐
Upper control station		
Guardrail system	Welds intact, no damage or deformation	☐
Platform extension	Proper operation	☐
Operating controls	Proper operation	☐
Emergency stop	Shuts off upper controls	☐
Lowering alarm	Sounds when platform lowers	☐
Drive motion alarm	Sounds when aerial platform moves	☐
Electrical power outlet	Proper operation	☐
Battery condition indicator (optional)	Proper operation	☐
Horn (optional)	Sounds when activated	☐
Placards and decals	In place and legible	☐

Frequent Maintenance (90 Day or 150 Hours)

Date:

Component	Procedure	Information	✔
Electrical system			
Batteries	Clean terminals, check electrolyte levels and cable connections	Add distilled water if necessary Insure batteries fully charged	☐
Battery charger	Proper condition		☐
Cables and wiring	Check for wear or damage		☐
Right and left drive motors	Check tightness, proper operation		☐
Hydraulic system			
Hydraulic fluid	Check fluid level	Mobil DTE-13M (above 10°F/-12°C) Mobil DTE-11M (below 10°F/-12°C)	☐
Hoses, tubes, and fittings	Check for leaks		☐
Free-wheeling valve	Full-closed position		☐
Return filter	First replacement after 50 hrs. (more often in dirty conditions)	Replace every 90-day maintenance procedure	☐
Fluid reservoir	Check for leaks		☐
Filler cap	Securely fastened		☐
Motor and pump assembly	Check for proper operation		☐
Fluid inspection	Check condition	See Chap. 7, Hydraulic System	☐
Structure and welds	Check for damage, cracks, dents		☐
Slide blocks	Check for wear and proper operation	Do not lubricate	☐
Bolts and fasteners	All tight and snug		☐
King pins	Lubricate	Conoco Super Sta #2 (OR) Mobilgrease CM-P (above 32°F/0°C) Mobilgrease CM-L (below 32°F/0°C)	☐
Wheels	Check for wear; torque all nuts/bolts to 70-80 ft lb		☐
Steering cylinder, fasteners and linkage	Check for damage, leaks, and proper operation		☐
Scissor arm assembly			
Pivot pins, snap rings, roll pins	Check for damage, wear, or missing		☐
Lift cylinder and valves	No damage or leaks, OK operation		☐
Safety prop	No damage or deformation		☐
Emergency bleed-down valve	Check for proper operation		☐
Hydraulic tubes and hoses	Check for leaks		☐
Wiring and electrical cables	Check for wear or damage		☐
Bearings	Check condition, do not lubricate, replace if worn		☐
Level sensor interlock	Check for proper operation	See Chap. 3, Maintenance	☐
Parking brakes	Check for leaks and proper operation		☐

Component	Procedure	Information	✔
Pothole protector interlock and alarm	Check for damage, proper operation		☐
Swing-out trays	Check for proper operation		☐
Tray hinges and latches	Lubricate	Powdered graphite	☐
Pothole protection pivot points	Lubricate	Spray lubricant	☐
Platform			
Lift capacity	Check lift operation at maximum load (500 lb/227 kg)		☐
Raise and lower (including emergency lower)	Check for smooth operation and proper speed		☐
Guardrail system	Check for damage, broken welds		☐
Platform extension	Smooth operation, locking pins OK		☐
Upper control station			
Drive/steer	Proper operation		☐
Emergency stop	Shuts off upper controls		☐
Lowering alarm	Sounds when platform lowers		☐
Drive motion alarm	Sounds when unit moves		☐
Electrical power outlet	Proper operation		☐
Travel speed	1. High: 2 mph (3.22 kph) maximum 2. Low: 0.4 mph (.64 kph) maximum		☐ ☐
Lower control station			
Operating controls	Proper operation		☐
Emergency stop	Shuts off all controls		☐
Lowering alarm	Sounds when platform lowers		☐
Control selector switch (and lockout)	Check lockout function	When lower controls are selected, upper controls won't work (and vice versa)	☐
Raise and lower switch	Check for smooth operation		☐
Battery disconnect switch	Shuts off all controls		☐
Placards and decals	Order replacements for damaged or illegible	Parts numbers in Parts Manual	☐
Operators manual	In manual holder		☐
Optional features			
Horn	Proper operation		☐
Flashing light	Proper operation		☐
Battery condition indicator	Proper operation		☐

Major Repairs			
Date	**Part #**	**Part Description**	**Repair Performed**

Annual Maintenance (500 Hours)

Date:

Component	Procedure	Information	✔
Frequent Maintenance Checklist	Complete all procedures		☐
Hydraulic fluid system	Drain, flush and clean system, and replace fluid (see Chap. 7.)	Mobil DTE-13M (above 10°F/-12°C) Mobil DTE-11M (below 10°F/-12°C)	☐
Hydraulic return filter	Replace	See Parts Manual for #	☐
Hydraulic pressures	Check pressures	See relief settings (Chapter 7)	☐
Wheel bearings	Clean and repack	Conoco Super Sta #2 (OR) MobilGrease CM-P (above 32°F/0°C) MobilGrease CM-L (below 32°F/0°C)	☐

Major Repairs			
Date	**Part #**	**Part Description**	**Repair Performed**

Chapter 4. Base Frame Assembly

Wheels

When removing wheels from the unit, park the unit on a hard, level surface. Using a suitable hoist or jack, raise the axle until the wheel clears the ground. Position a jack stand of sufficient capacity beneath the axle and lower the unit to rest on the stand. Never rely solely on the jack or hoist. Remove the lug nuts and wheel.

Wheel Drive Motors

To remove a wheel drive motor for service, the wheel must first be removed following the above instructions. Once removed, the motor shaft nut is exposed. Remove the nut. Wipe clean and disconnect the two hose fittings on top of the motor (figure 4.1). Remove the four nuts fastening the motor to the mounting plate. The motor should now be free for service.

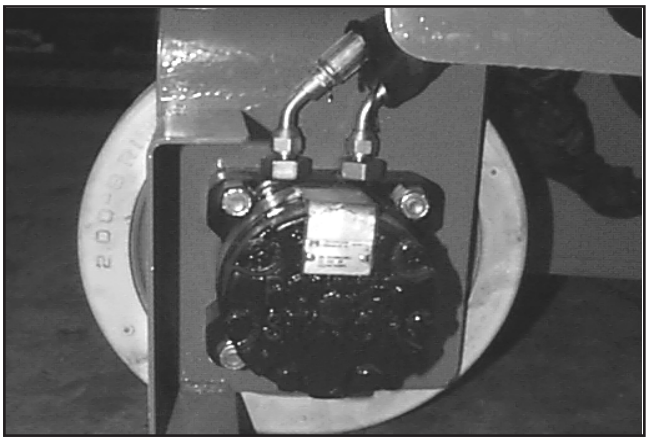


Figure 4.1—Wheel Motor and Fittings

Wheel Motor Service

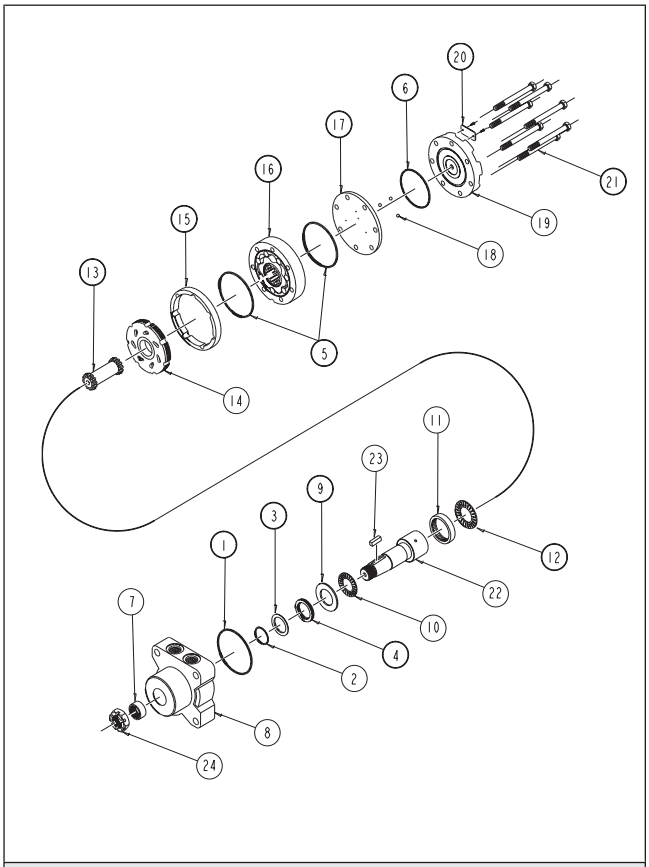
To prevent contamination, the disassembly and service of a wheel drive motor should only be performed by authorized personnel in a clean, properly equipped shop. Field service is not recommended. The service procedures will require:

- Seal kit (see Parts Manual for correct part no.)
- Slide hammer bearing puller
- Bench vise
- Hand press
- Hand wrenches
- Clean work bench

Prior to installing new seals, lightly coat them with new hydraulic fluid.

Disassembly

Refer to figure 4.2 for identification of all components in the motor.



#	Description	#	Description
1	Housing seal	13	Drive link
2	Metal back-up shim	14	Manifold
3	Teflon back-up seal	15	Manifold boot
4	Shaft seal	16	Rotor assembly
5	Body seals (2)	17	Balance plate
6	End cover seal	18	Check balls (3)
7	Front housing seal	19	End cover
8	Housing	20	I.D. tag
9	Thrust washer	21	Assembly bolts
10	Front thrust bearing	22	Shaft
11	Rear housing bearing	23	Shaft key
12	Thrust bearing	24	Shaft nut

Figure 4.2—Wheel Drive Motor

1. Remove all components from the shaft (keys, wire rings, nuts, etc.). Draw a line with paint or marker from the end cover (19) to the motor housing (8) to facilitate proper alignment during reassembly.
2. With the shaft pointing down, secure the motor in a vise by clamping on the housing. Loosen and remove the assembly bolts (21). Remove the end cover.
3. Remove the balance plate (17), rotor assembly (16), manifold boot (15), and the manifold (14).

Note: When removing the balance plate, do not allow the three check balls (18) to fall out. Also, take care to not allow the rolls to drop out of the rotor assembly.

4. Locate and discard all seals. They will be replaced during service and reassembly.
5. Remove the drive link (13) and thrust bearing (12).
6. From the underside, gently tap the shaft (22) upward and remove.
7. Using a slide hammer bearing puller, remove the rear housing bearing (11) from the housing.
8. Remove the front thrust bearing (10) and the front thrust washer (9).
9. Locate and discard the shaft seal (4), back-up seal (3), and metal back-up shim (2).
10. Clean and dry all disassembled parts with solvent (take care to observe all OSHA safety guidelines).

⚠CAUTION

Solvents can be extremely hazardous. Follow the manufacturer's label for proper use and disposal.

Assembly

1. Stand the shaft (22) on the work space (large end down) and place the front thrust bearing (10) onto the shaft (the washer side against the shoulder). Place the thrust washer (9) on top of the bearing.
2. Remembering to lightly coat all new seals with new hydraulic fluid, install a new shaft seal (4) onto the washer, lip-side down. Install a new back-up seal (3) followed by a lightly oiled new metal shim (2).
3. Put the housing (8) in a vise (taking care to not deform the part) with the bore hole down. Install the shaft assembly down through the bore.
4. The rear housing bearing (11) is now ready to be installed. With the writing side up, place the bearing into the housing bore. Using a hand press, partially press the bearing into the bore no more than .12″-.13″.
5. Install the thrust bearing (12) on top of the shaft.
6. Install a new housing seal (1) into the housing seal groove. Make sure the seal is uniformly installed and protruding approximately .007″ above the housing wall.

Note: If there is a bump in the seal, remove it and clean out the groove. Any irregularity will defeat the seal.

7. Install the drive link (13) into the housing. One end of the link has a "hat" machined in it. Place the other end in the shaft leaving the "hat" end exposed.
8. Now the shaft can be seated. Using the hand press, apply downward pressure on the drive link.

Note: Do not use excessive force which may deform the thrust bearing and/or the bearing races.

9. Place the manifold (14) (with the seven tear-drop shaped holes facing down) over the drive link.
10. Align the seven bolt notches around the outside of the manifold with the bolt holes in the housing. Place the manifold boot (15) (groove side up) around the manifold, onto the housing.
11. Install two new body seals (5) into the grooves on both faces of the rotor (one on each face).
12. Place the rotor (deep groove side down) on the manifold.
13. Place the balance plate (17) (with the three check ball dimples up) on top of the rotor. Replace the three check balls into the dimples.
14. Install the end cover seal (6) into the seal groove of the end cover (19).
15. Place the end cover onto the balance plate with the ID tag holes directly above the housing ports.

Note: Be very careful that the seal does not fall out but remains securely in place.

16. Align the components using the painted or drawn line from step one. Install seven bolts (21) through the end cover, through the aligned holes in the motor, and into the housing. Pre-torque the bolts to 10 ft. lb. The final torque should be 51.1 5.5 ft lb.

Wheel Motor Hose Attachment Guidelines

Note: It is very important that wheel motor hoses be attached properly. The normal steering movement of the wheels can cause premature wear and leakage of any hoses and fittings that are improperly installed.

If wheel motor hoses are removed during any service procedure the following connection guidelines are important to follow (refer to the hydraulic schematic in Chapter 8, Troubleshooting, for hose identification):

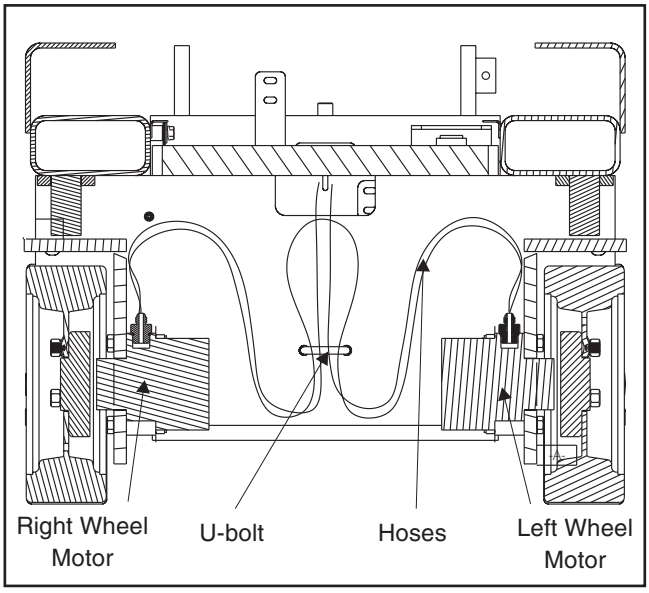


Figure 4.3—Hose Routing (front view)

- After routing the power hoses through the access hole in the back wall of the wheel chamber and through the u-bolt mounted to the wall, attach both hoses to the “B” ports of the right and left motors. Measure 22 inches from the u-bolt to the right motor and 18 inches from the u-bolt to the left motor (see figure 4.3). The ports are clearly labeled on top of each motor.
- Route the connecting hose from port “A” of the right motor to port “A” of the left motor through the u-bolt with 19 1/2 inches of hose from the u-bolt to the right motor and 23 inches of hose from the u-bolt to the left motor (figure 4.3).
- All 45° hose fittings should be oriented rearward and against the motor mounting plate (figure 4.1).
- Following the instructions under “Fittings” in chapter 7, Hydraulic System, secure the hose fittings to the proper ports on the motors. The fittings should be torqued to 21 ft lb.
- Be sure to cover all exposed hoses with woven abrasion guard material and install zip ties every 6 inches.

Pothole Protection

Pothole protection is a safety feature that is designed to prevent tip-over. It consists of two skids (figure 4.4) along each side of the machine that deploy into a down position when the platform is raised to approximately 6 feet.

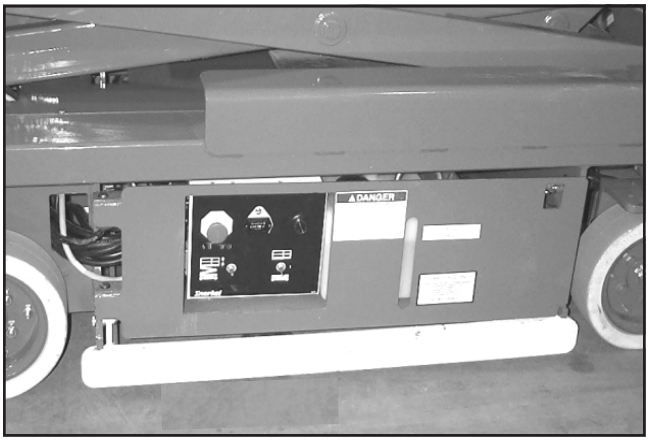


Figure 4.4—Pothole Protector Skid

These skids effectively lower the machine’s wheel base to a height of only 3/4″ which protects against a tipover hazard should a wheel sink or drop into a pothole.

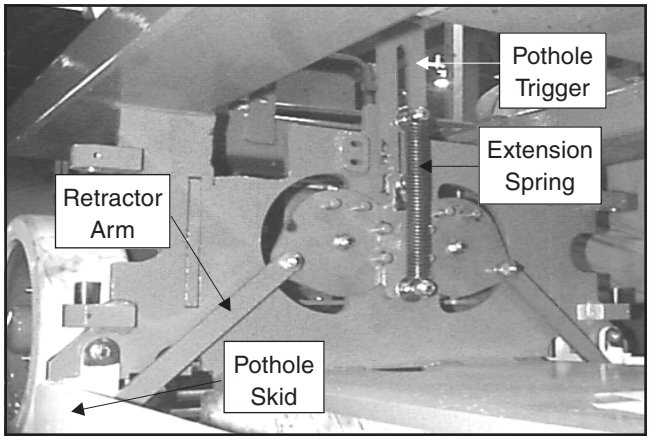


Figure 4.5—Pothole Mechanism

The skids retract into an up position when the platform is lowered and the pothole activator bar, which is attached to the scissor assembly, lowers onto and depresses the pothole trigger (figure 4.5).

Chapter 5. Scissor/Platform Assembly

Platform Assembly

Most of the operating functions of the machine, including lift and drive, can be performed on the platform at the upper controls. For safety purposes, any personnel operating the machine from the upper controls should be attached to the platform by a fall restraint system.

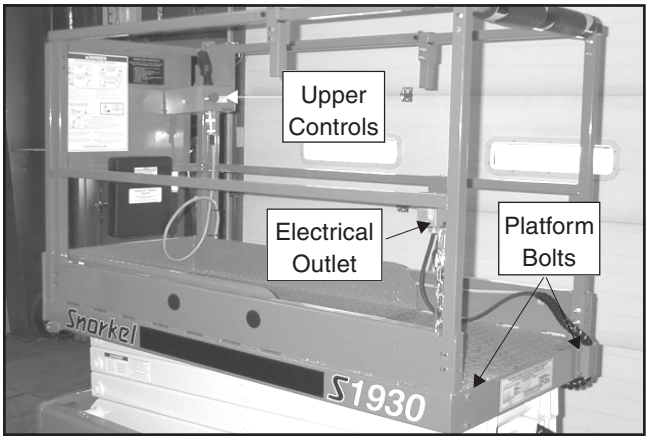


Figure 5.1—Platform Assembly

Platform Removal Procedure

1. Disconnect electrical cables from base of upper control box.
2. Disconnect electrical wires from rear of electrical outlet and pull free of platform.
3. Remove four bolts (figure 5.1 & 5.2) from the base at the rear.

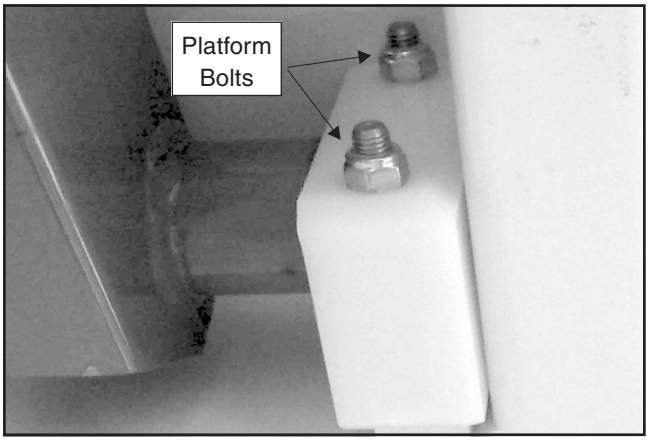


Figure 5.2—Platform Bolts

4. Lift the rear of the platform a few inches, sufficient to clear the scissor assembly.
5. With the platform properly supported by a hoist or lift, slide it forward and off the scissor assembly.

Scissor Assembly

The platform is mounted on the scissor assembly which contains the lift cylinder, the stack wiring harness and two important safety features of the machine, the safety prop (figure 5.5) and the emergency bleed-down valve (figure 5.6).

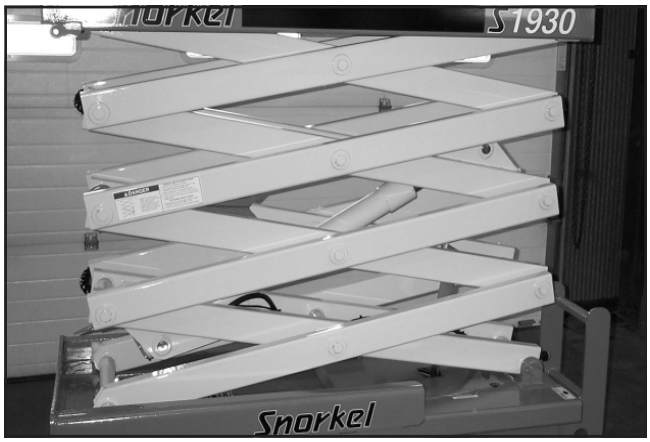


Figure 5.3—Scissor Assembly

Scissors Removal Procedure

1. Raise the platform, drop and secure the safety prop into position.
2. Detach all electrical and hydraulic connections to the base assembly (be sure the battery switch is off and pressure is removed from hydraulic lines).
3. Remove platform ladder (figure 5.4).
4. Remove pin bolt (figure 5.4).
5. With a hammer and punch, remove the scissor pin (figure 5.4).
6. The back of the assembly should now be free of the base mounts. With the assembly properly supported by a hoist or lift, slide the assembly toward the rear until the slide blocks are free of the channel assembly.

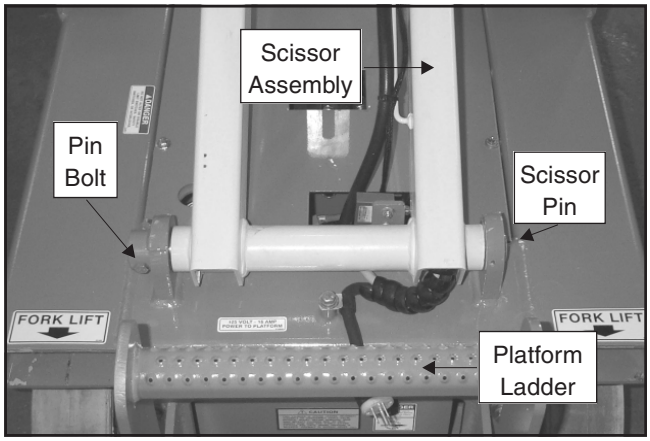


Figure 5.4—Scissors Removal

Safety Prop

The safety prop (figure 5.5) is a heavy-duty bar to be dropped into position preventing the scissors from collapsing, a safety feature designed to prevent injury. It is located at the rear of the scissor assembly.

To secure it in position, raise the platform sufficiently high to allow the prop to drop and swing freely. Align the bottom of the prop so that, when lowered, it straddles and secures itself to the scissor pin directly beneath it (see figure 5.5). Slowly lower the platform until the prop fully blocks and supports the weight of the platform.

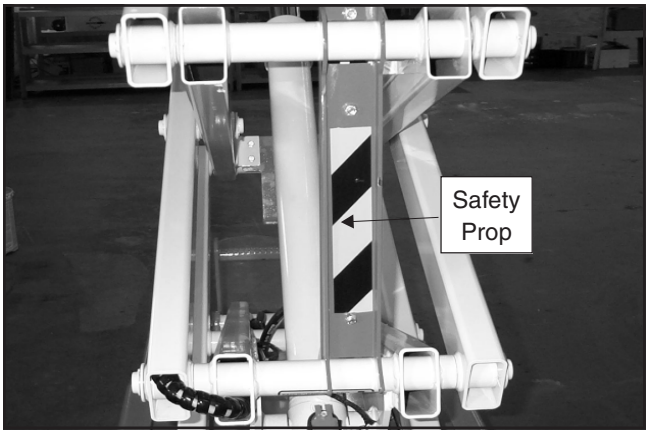


Figure 5.5—Safety Prop

Emergency Bleed-Down Valve

The emergency bleed-down valve (figure 5.6) will relieve the pressure on the lift cylinder and smoothly lower the platform. It is located at the front of the scissor assembly. To activate it, simply depress the lever.

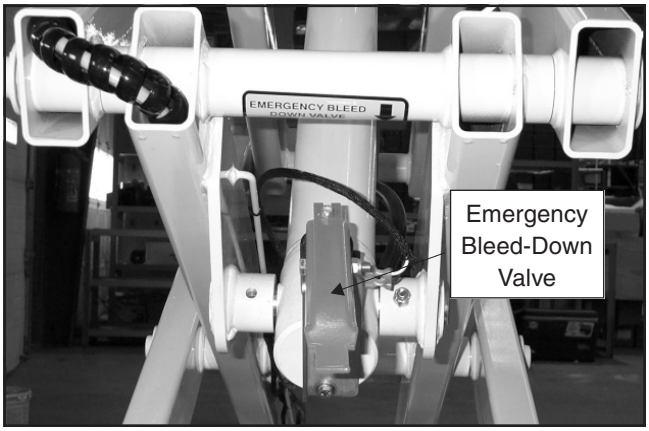


Figure 5.6—Emergency Bleed-Down Valve

Chapter 6. Electrical System

System Components

Maintenance of the electrical system will often require the use of a voltmeter and reference to the wiring diagrams and schematics found in Chapter 8, Troubleshooting.

Wiring Harness

⚠CAUTION

To avoid personal injury or damage to the electrical system, do not disconnect any wiring without first turning the battery switch to off and disconnecting the battery ground cable from the battery.

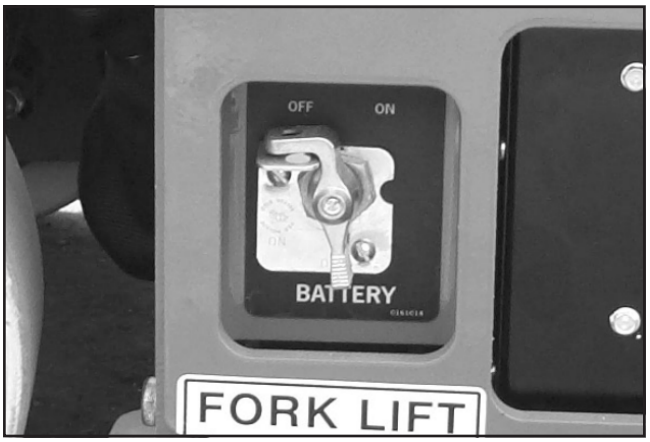


Figure 6.1—Battery Switch Off

Repair

Remove a wiring harness only if it is damaged or unusable. If a wire must be spliced or repaired, be sure to solder the connection with rosin core solder. If wires are to be replaced, always use the same gauge, never smaller. Always protect the connections with electrical connectors or insulating tape.

Removal and Installation

For efficient installation of a new harness, connect the new one as you disconnect the old one or tag the wires to insure proper installation.

Take care to insure that the harness is installed properly. Be careful to replace all harness clips and tie wraps as they were. This should prevent chafing and/or wear due to vibration. Connection diagrams are found at the back of chapter 8, Troubleshooting.

Lower Control Box

The schematic for the lower control box is located at the back of Chapter 8, Troubleshooting.

The most common maintenance point in the control box is the fuse (figure 6.2). Replace a burnt-out fuse with a 20 amp AGC type Buss fuse (1/4″ X 1 1/4″).

Contact corrosion is a common problem. It is a good idea to periodically clean the contacts with a contact cleaner.

The speed adjustment potentiometer (figure 6.2) controls the drive speed of the unit and is preset and locked at the factory. If the unit develops an improper drive speed, check to see that the control setting has not been altered.

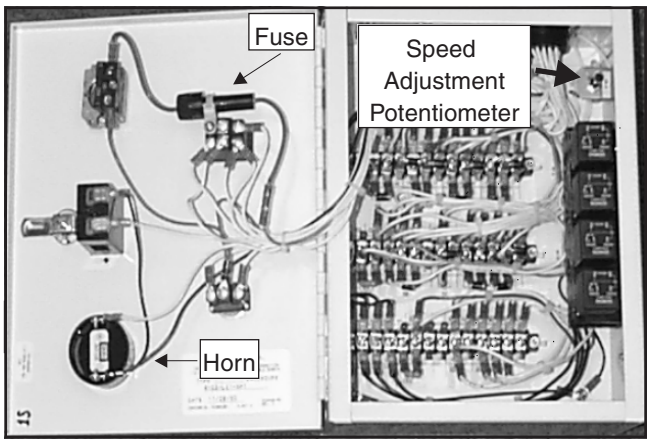


Figure 6.2—Lower Control Box

Upper Control Box

The schematic for the upper control box is located at the back of Chapter 8, Troubleshooting.

The joystick control (figure 6.3) is mounted on top of the upper control box.

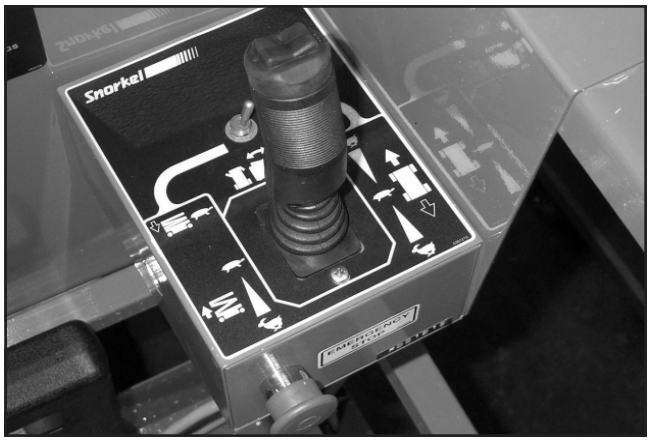


Figure 6.3—Joystick Control

Schematics and Drawings

The following schematics and drawings are found at the back of Chapter 8, Troubleshooting:

- Electrical Schematics
- Wiring Harness Connections
- Battery Cable Connections
- Joystick

Chapter 7. Hydraulic System

General Maintenance

Maintaining the hydraulic system is critical to the performance of the machine. Any fluid used must meet Snorkel specifications. The system is kept clean by closely following the recommended maintenance schedules.

Hydraulic Fluid Specifications

- Mobil DTE-13M (above 10°F/-13°C) (factory installed)
- Mobil DTE-11M (below 10°F/-13°C)

Cleanliness

In the system, dirt, water, and air can all be damaging. Because contamination is so harmful, precautions are very important. Be careful when adding fluid, changing filters, or performing other service procedures.

- Check fluid levels during each prestart checklist routine.
- Replace the return filter at recommended intervals, more often if conditions are dirty.
- Filter new fluid with a 10 micron filter as it is added to the reservoir.
- Wipe connections clean before opening them.
- Plug or cap ports and lines opened for service.
- Stored replacement hoses and components should be kept covered or plugged.
- Check all components for cleanliness prior to installation.
- Wipe clean the reservoir, filter housings and breather cap before opening.
- Do not spray water on the filler-breather cap. This could force contaminants into the reservoir.

Hydraulic Pump

Routine service is necessary to keep the pump running smoothly. There are, in addition, several potential problems to watch out for.

Cavitation

Cavitation occurs when inlet oil does not entirely fill the cavities that occur during the intake step of the pumping cycle. The pump tries to draw a vacuum causing the cavitation which is characterized by a high-pitched scream. The following are potential causes:

- Excessive pump speed
- Clogged suction filter
- Excessive fluid viscosity (too thick)
- A kink or sharp bend in hose or tubing
- Excessive length of inlet hose
- Low fluid level
- Shutoff valve fully or partially closed

To help prevent cavitation during cold temperatures, allow the fluid to warm by initially operating the machine at a slow speed.

⚠CAUTION

Cavitation can quickly destroy the pump. At the first sign of a problem, shut down the unit and repair the problem.

Aeration

Aeration occurs when air bubbles are forced into the fluid and carried along as it circulates. When the pump operates with air in it, serious damage can occur. Signs of aeration are foamy fluid in the reservoir and noisy pump operation. The following are potential causes:

- Low fluid level. The pump will then tend to suck air into the system along with the fluid.
- A leak in the suction line between the reservoir and the pump.
- Return line outlet is located above the oil level in the reservoir. The resulting turbulence can mix air into the fluid.

To check for a suction line leak while the pump is running at normal speed, slowly squirt clean hydraulic fluid around each connection in the line and the O-ring flange where it bolts to the pump. Listen to the pump. A suction leak will suck the fluid in and quiet the pump as long as the oil seals the leak. Each leak must be repaired.

⚠CAUTION

Serious pump damage is likely if leaked air contaminates the hydraulic fluid. At the first sign of trouble, shut down the machine and repair the problem.

Air Bleeding

Air can bleed into the system causing pump damage. This can be caused by low fluid level in the reservoir or loose connections and fittings in the system. Or, during maintenance, opened lines can suck in air.

Most lines in the system will purge air during normal use. However, if air is detected in the system, a manual purge procedure is recommended.

Fluid Leakage

All hydraulic connections must be kept tight to prevent fluid leakage. Be sure a thorough check of the entire system is part of each prestart inspection routine.

⚠DANGER

Hydraulic fluid escaping under pressure can have enough force to inject fluid into the flesh. Do not expose hands or any part of the body to a potential fluid leak. Serious infection or reaction can result from injury by escaping hydraulic fluid. Seek medical attention at once.

Be careful of leaked or spilled fluid. Hydraulic fluid creates a very slippery fall hazard. Clean up all spills at once.

A connection that is properly tightened but continues to leak is probably worn, scratched, or damaged and must be replaced.

Although small amounts of internal system leakage is normal, due to machining tolerances, major internal leaks can cause serious problems.

Leakage past a holding valve in a cylinder can cause drifting or malfunction and may require replacement of the valve.

If internal cylinder leakage is due to scoring of the cylinder wall, be careful of attempted repairs. Only trained professionals should attempt removal of scratches from the inside of a cylinder barrel.

⚠DANGER

Do not modify the interior of a cylinder barrel beyond manufacturing tolerances. This can cause the piston seal to fail leading to total cylinder failure. Cylinder failure can result in death, serious injury, and/or property damage.

Field service of hydraulic cylinders is not recommended for two reasons: 1. potential for contamination, and/or 2. limited equipment and facilities. Disassembly and repair of such components must be performed by authorized personnel in a clean, properly equipped shop. During the assembly process, be sure to always replace old seals with new. Seal kit parts numbers are in the Parts Manual.

Heat Generation

Continuous operation of an overheated machine will damage the fluid, seals, and o-rings within the system. Heat is generated when pressurized fluid escapes to the reservoir prior to performing its work. Heat generated, due to the small amount of internal leakage because of machining tolerances, has been compensated for in the system design. However, larger leaks due to housing cracks, defective relief valves, or worn seals (for example), allow excessive fluid return to the reservoir, creating surplus heat. The following conditions may also generate excessive heat :

- Excessive pump speed during high-flow operation
- Worn or faulty pump
- Low fluid level
- Improper fluid used

Fluid Condition

Visually inspecting a sample of the hydraulic fluid during the 90-day maintenance routine can provide important clues to potential problems in the system. Before taking a fluid sample, operate the unit to warm and circulate the fluid. Take the sample from the middle of the reservoir. This can be done by using a clean hand pump or disposable syringe and a piece of plastic tubing. If you must take the sample from the bottom drain, allow several quarts to drain prior to catching your sample. This will insure that you don't collect contaminants that may have settled to the bottom. Compare the sample to a sample of new fluid and a sample of a previous inspection (if available).

Condition	Possible Cause
Dark color	Oxidation, contamination
Cloudiness or milkiness	Water or wax in fluid
Rancid or burned odor	Oxidation
Increase in viscosity	Oxidation, improper additives, water in fluid
Decrease in viscosity	Improper additives, additive deterioration
Layers of fluid	Water or improper additives
Foreign particles	Contamination, emulsion of water

Figure 7.1—Visual Fluid Inspection

Oxidation is a chemical reaction that occurs when air reacts with various compounds in the fluid. High operating temperatures will increase the rate of oxidation, as will the presence of water or air. Oxidation produces varnishes that bake onto hot surfaces. These varnishes are acidic and will attack metal surfaces, causing damage to pumps, motors, and valves.

Additionally, the presence of water can cause rust and corrosion in the system and reduce the dielectric capability of the fluid.

Another, more accurate method of fluid inspection is laboratory analysis. Your fluid supplier should be able to supply you with the name of a test lab in your area.

However you inspect the fluid, it is important that you quickly respond to any evidence of a problem, locating and correcting it.

Flushing the System

Properly maintained, the filtration system greatly extends the useful life of the fluid. However, due to the accumulation of contaminants during normal operation of the machine, the fluid eventually will require replacement.

Fluid Replacement Guidelines

Because of varying environmental and operating conditions it is impossible to recommend an exact interval for fluid replacement. The following are helpful guidelines:

- Always flush the system and change the fluid during the annual maintenance routine.
- In dirty environments, flush and change more frequently.
- Always flush and change the fluid following a component failure that introduced metal particles into the system.
- If you operate in a climate with wide temperature variations, change to the appropriate weight of fluid each spring and fall (see Chapter 2, Specifications).
- Always use fluid that meet or exceeds Snorkel specifications.

Return Filter

The return filter cartridge (figure 7.2) should be changed after the first 50 hours of operation; thereafter, change during every 90-day maintenance routine or when the system is flushed. If the machine is operated in a dirty environment, the filter should be changed more often. The part number is listed in the Parts Manual.

Flushing Instructions

After draining the fluid from the reservoir, it is necessary to flush the system to remove the fluid trapped in cylinders and lines, otherwise it will contaminate the new fluid. This is especially important if the system was contaminated with metal particles due to a part failure.

Required flushing equipment and supplies:

- Approximately 7 gallons of hydraulic fluid (see Chapter 2, Specifications).
- One (possibly two) replacement return filter cartridge(s) (see Parts Manual for part number).
- Clean, lint-free rags.
- A 10 micron filter.

⚠CAUTION

Spilled hydraulic fluid creates a very slippery fall hazard. Clean-up all spills at once.

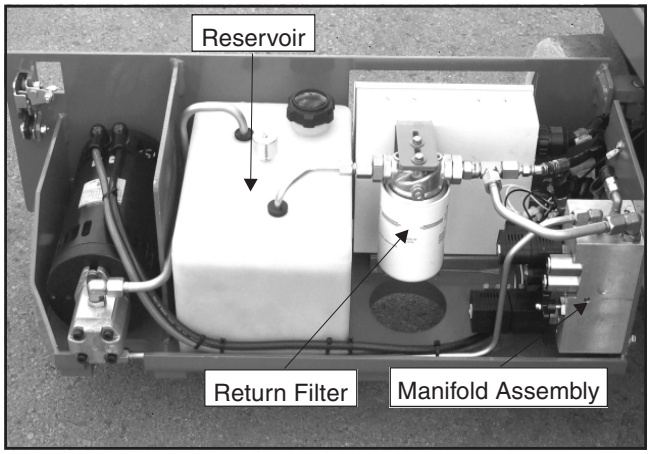


Figure 7.2—Hydraulic Tray

Flushing the hydraulic system:

1. Operate the unit to warm and circulate the fluid. This will suspend the bulk of contaminates, allowing them to drain out with the fluid.
2. Open the drain plug in the bottom of the reservoir (figure 7.2) and allow the fluid to drain completely. Disposal of the old fluid must be in compliance with all local laws and regulations.
3. Wipe clean the top of the reservoir, filler cap, and return filter (figure 7.2).
4. Remove the filler cap and inspect the inside of the reservoir. Clean out any sludge or contamination using solvent and rags.

⚠DANGER

Solvents present a potential flash fire hazard. Keep away from heat, sparks, and flame. Follow the manufacturer's label for proper use and disposal.

5. If flushing the system because of contamination due to a component failure, replace the return filter with a new one prior to flushing. Also, drop a magnet into the reservoir to collect metal contaminants.
6. Fill the cleaned reservoir with new hydraulic fluid filtered through a 10 micron filter.
7. Cycle the fluid throughout the system, all cylinders and motors, by cycling the machine through all its functions (driving and lifting). This flushes the contaminated fluid from all components and lines to be collected in the reservoir.
8. Completely drain the reservoir again, properly disposing of the contaminated fluid. Retrieve the magnet installed during Step 5.
9. Replace the dirty return filter with a new one.
10. Fill the reservoir with new fluid to the fill mark, filtering through a 10 micron filter.

Note: Change the filter of a new machine after the first 50 hours of operation. Thereafter follow maintenance checklist guidelines.

Fittings

Most hydraulic ports and fittings are SAE straight thread with o-rings. They have been selected because they provide excellent sealing and vibration resistant qualities. When handling or storing hydraulic components, use caps and plugs to prevent damage or contamination.

When tightening fittings, be careful not to over tighten. The fittings must be tight and snug, but over tightening may damage or deform the part, causing leaks.

Torque Specifications

Tube to Fitting (37° Flare)

Torque Method:

1. Align tube and fitting.
2. Tighten nut to torque spec below:

SAE Dash Size	Thread Size	Torque (ft lb)	Tube Connection F.F.F.T.	Hose Connection F.F.F.T.
-2	5/16-24	3±1	-	-
-3	3/8-24	6±1	-	-
-4	7/16-20	12±1	2	2
-5	1/2-20	15±1	2	2
-6	9/16-18	21±1	1½	1¼
-8	3/4-16	45±2	1½	1
-10	7/8-14	60±5	1½	1
-12	1 1/16-12	85±5	1¼	1
-14	1 5/16-12	105±5	1	1
-16	1 5/16-12	120±5	1	1
-20	1 5/8-12	170±10	1	1
-24	1 7/8-12	200±15	1	1
-32	2 1/2-12	270±20	1	1

Figure 7.3—Tube to Flare Fitting

Flats Method (F.F.F.T./flats from finger tight):

1. Tighten nut to finger tight.
2. Mark off nut and body (figure 7.4).
3. Tighten to appropriate F.F.F.T. from above chart.
4. Mark off final position (figure 7.4).

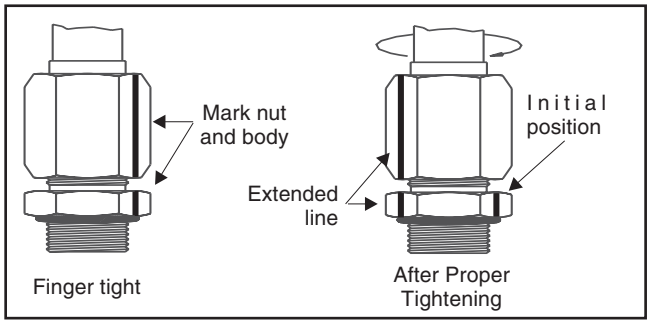


Figure 7.4—Nut Tightened to 2 F.F.F.T.

Straight Thread O-Ring Fitting (non-adjustable)

1. Lubricate o-ring with fluid.
2. Tighten to finger tight.
3. Tighten to torque spec below:

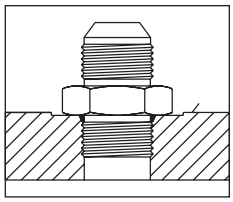


Figure 7.5

Fitting Size	SAE PortThread Size	Torque (ft lb)
2	5/16-24	7.5±0.5
3	3/8-24	14±1.0
4	7/16-20	18±1.0
5	1/2-20	22±1.0
6	9/16-18	27±2.0
8	3/4-16	48±2.0
10	7/8-14	90±5.0
12	1 1/16-12	110±5.0
14	1 3/16-12	145±6.0
16	1 5/16-12	160±6.0
20	1 5/8-12	225±12.0
24	1 7/8-12	250±12.0
32	2 1/2-12	325±15.0

Figure 7.6—Straight Thread (non-adjustable)

Straight Thread O-Ring Fitting (adjustable)

Adjustable fittings require alignment. The following steps insure proper installation.

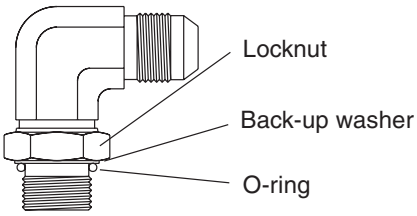


Figure 7.7—Straight Thread (adjustable)

1. Lubricate o-ring with fluid.
2. Back locknut off as far as possible. Make sure back-up washer is not loose and is pushed up as far as possible (figure 7.8, a).
3. Screw the fitting into the port until finger tight. The back-up washer should contact the face of the port (figure 7.8, b).
4. Align the fitting as needed by unscrewing the required amount, but less than one full turn.
5. Use a wrench to hold fitting in desired alignment. Tighten the locknut with a torque wrench to torque spec listed below (figure 7.8, c):

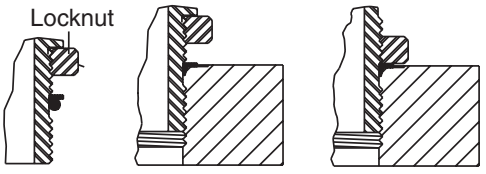


Figure 7.8—Locknut Procedure

Fitting Size	SAE Port Thread Size	Torque (ft lb)
2	5/16-24	5.5±0.5
3	3/8-24	11±1.0
4	7/16-20	14±1.0
5	1/2-20	22±1.0
6	9/16-18	27±2.0
8	3/4-16	42±2.0
10	7/8-14	60±2.5
12	1 1/16-12	80±5.0
14	1 3/16-12	105±6.0
16	1 5/16-12	115±6.0
20	1 5/8-12	225±12.0
24	1 7/8-12	250±12.0
32	2 1/2-12	325±15.0

Figure 7.9—Straight Thread (adjustable)

Leaky Fittings

If any connection leaks after final assembly or once the system is pressurized, check for the following:

- Proper number of flats used for the size being assembled.
- Misalignment between the connections prior to tightening.
- Mating components lubricated prior to assembly.
- Sealing surfaces of the components inspected for nicks, burrs, scratches, etc.

Hoses and Tubes

Any replacement hose or tube used on the machine must meet or exceed Snorkel original equipment specifications. Hoses are flexible, tubes are rigid.

Check SAE working pressure and burst pressure ratings printed on the hose. Make sure they equal or exceed that of the original. Make sure, also, that the diameter of the replacement is the same as the original, neither larger nor smaller. Any change in diameter from design specifications can have a dramatic and damaging effect on fluid flow.

⚠DANGER

Hydraulic fluid escaping under pressure can have enough force to inject fluid into the flesh. Do not expose hands or any part of the body to a potential fluid leak. Serious infection or reaction can result from injury by escaping hydraulic fluid. Seek medical attention at once.

Plug or cap all open ports and lines to prevent contamination. This will also prevent damage to sealing surfaces and fitting threads.

Hose Routing

A good rule to follow is that if the installation “looks” good it probably is. Always route for proper appearance. Routing tips:

- Route the hose to avoid abrasion and chafing.
- Always leave some slack when installing straight hose. Pressure changes during operation can sometimes shorten the hose.
- Make sure the hose flexes in the same plane as the bend.
- Make bends gradual, not sharp. Route the hose to extend straight out from fittings for a minimum distance of double the I.D. before beginning a bend.

Hose Twist

Never twist the hose during installation. Twisting shortens hose life and can cause premature failure. It also places an unscrewing pressure on the fitting, causing it to work loose. If the printing on the hose is straight, the hose is probably straight also.

To prevent twisting the hose during installation, use two wrenches. Use one wrench to hold the fitting and the other to tighten the nut.

Manifold Assembly

The manifold assembly (figures 7.10 & 7.11) contains a series of solenoid activated directional valves that direct the flow of fluid throughout the system. It also contains system, steering, and lift pressure relief valves. The test ports for pressure checks are also located here.

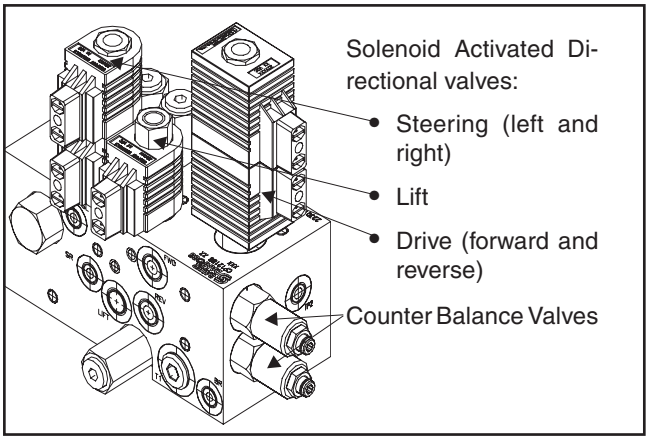


Figure 7.10—Manifold Assembly

Free Wheeling Valve

The free wheeling valve (figure 7.11) is mounted on the manifold assembly. It is a needle valve that, when opened, diverts the fluid flow allowing the wheels to turn freely, which allows the machine to be towed or pushed. During normal operation, it should be closed.

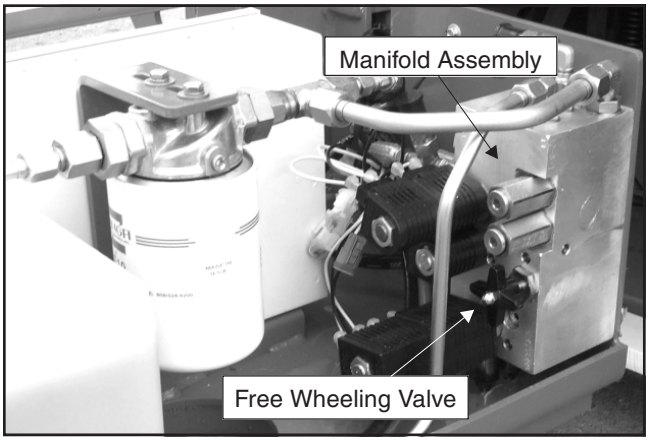


Figure 7.11—Free Wheeling Valve

System, Steer, and Lift Relief Settings

The following adjustment procedures require the use of a 0 to 5000 psi pressure gauge.

System Relief Adjustment

1. Attach test gauge to the system test port (figure 7.12).
2. Remove wire 17 from the forward drive solenoid (17) (figure 7.13).
3. At the platform, put the lift/drive switch in drive and move the joystick forward to the full-on (stall) position.

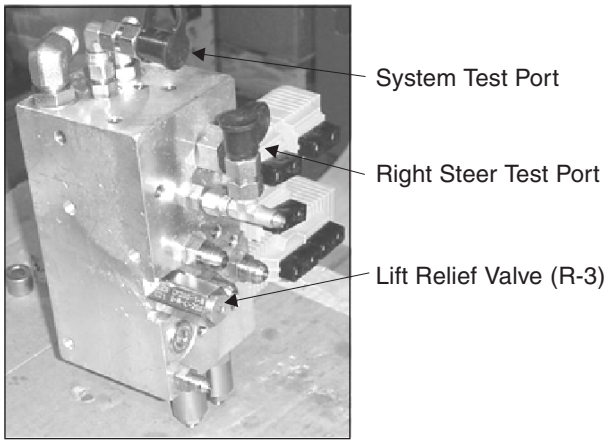


Figure 7.12—Test Ports and Lift Relief

4. Check the pressure at the test port. It should read between 2750 and 2850 psi. If yes, the valve is properly set. If no, go to steps 5 and 6.
5. To adjust the relief setting, remove the external cap from the system relief valve (figure 7.13).

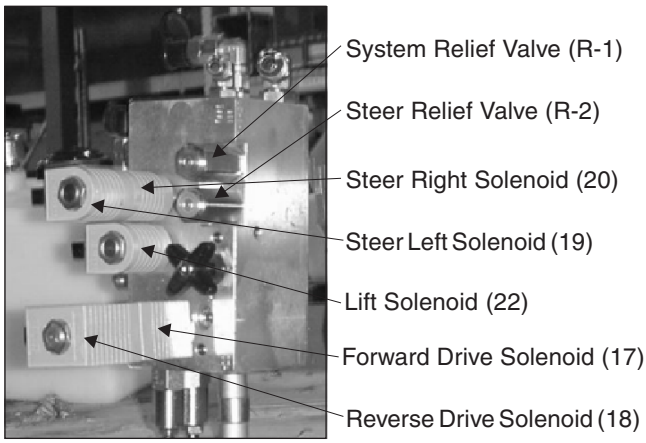


Figure 7.13—Solenoids and Relief Valve

6. Turn the inner set screw clockwise to increase the pressure setting. Counter-clockwise will decrease the setting.

Note: Be sure the joystick is in full-on (stall) position when checking the pressure.

7. Reattach wire 17 to the forward drive solenoid (17).

Steer Relief Adjustment

1. Attach test gauge to the right steer test port (figure 7.12).
2. At the platform, activate the steer switch on the joystick to maximum right turn (dead head).
3. Check the pressure at the test port. It should read 1500 psi. If yes, the valve is properly set. If no, go to steps 4 and 5.
4. To adjust the relief setting, remove the external cap from the steer relief valve (figure 7.13).

5. Turn the inner set screw clockwise to increase the pressure setting. Counter-clockwise will decrease the setting.

Note: Be sure the steer switch is in right turn dead head position when checking the pressure.

Lift Relief Adjustment

1. Attach test gauge to the system test port (figure 7.12).
2. Load the platform with 500 pounds of weight.
3. Raise the platform from the lower controls while watching the test gauge. It should read approximately 2500 psi. The reading should be taken before the platform reaches six feet and the scissor assembly lifts off the speed limit switch. If 2500 psi, the valve is properly set. If not, go to steps 4 and 5.
4. To adjust the relief setting, remove the external cap from the lift relief valve (figure 7.12).
5. Turn the inner set screw clockwise to increase the pressure setting. Counter-clockwise will decrease the setting.

Hydraulic Pump

The hydraulic pump (figure 7.14) is responsible for the movement of all fluid in the machine and, as such, is the heart of the hydraulic system. It is mounted directly to the pump motor inside the hydraulic tray.

Pump Service

The service of the hydraulic pump requires a replacement seal kit (see the Parts Manual for the part number). The removal of four bolts allows the disassembly of the pump. Pay special attention to the disassembly procedure so that the components may be reassembled exactly as taken apart.

The seal kit contains two o-rings, two seals, two plastic gaskets, and a shaft seal. Discard the old seals and gaskets. Lightly coat the new seals with hydraulic fluid and replace them as you remove the old.

Reassemble as taken apart.

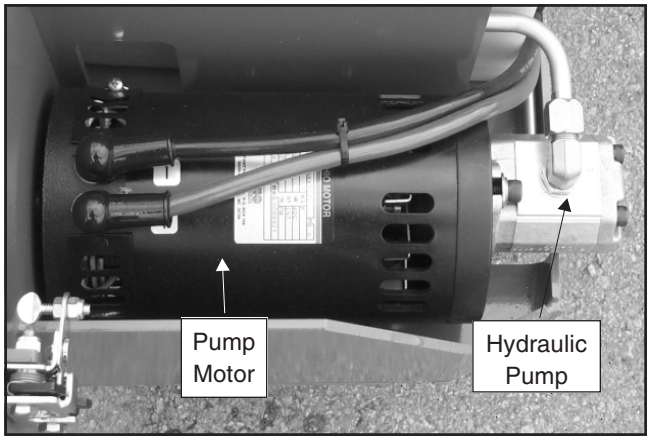


Figure 7.14—Hydraulic Pump

Pump Motor

This permanent magnet motor (figure 7.14) differs from conventional D.C. motors in that the field winding has been replaced with ceramic magnet pole pieces.

Note: Do not impact, drop, or squeeze the motors as this can cause damage to the ceramic pole pieces and will affect warranty considerations.

When disassembling the motor, take care to keep the work area clean. The magnet pole pieces will attract ferrous metal particles, contaminating the motor.

Motor Troubleshooting

1. Read the nameplate to become familiar with the motor, especially the rated voltage.
2. Keeping motor leads separated, try to turn the shaft by hand.

   a. If the shaft won't turn, the following steps will help determine the problem. Obtain a power source of the nameplate voltage. Do not make a permanent connection. Tap the motor leads to the power source (just long enough to observe if the shaft turns). If it does turn, connect the power for a longer time. If the motor operates normally, go to step b.

   If the shaft still won't turn or makes noise as it runs, disassemble it following the instructions.

   b. If the shaft turns freely, connect an ammeter to one of the power leads as shown on Figure 7.15. With the power connected and the motor turning freely the ammeter should read less than 20% of the full-load current (from the nameplate). If it does, the motor is functioning properly and the problem is elsewhere.

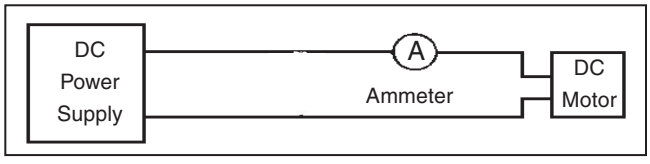


Figure 7.15—Ammeter Connection

Disassembly

1. Remove motor assembly bolts.
2. Remove pulley end cover.
3. Pull the armature out of the assembly in one swift motion.

Note: The armature must be completely removed in one continuous motion. Do not pull part-way out and release. If this is done, the magnets will pull the armature back into the stator and cause severe damage.

4. Remove commutator end cover.

Note: Do not place the stator ring in any mechanical holding device (such as a vise) during the disassembly or assembly operation. Permanent distortion or other damage will result.

5. Remove bearings from armature shaft. If using a bearing puller, take care to not damage the armature.

Component Exam and Repair

Once the motor has been disassembled, the following trouble-shooting and repair steps should restore the motor to full function.

1. Examine the bearings. They should spin smoothly and easily, free of corrosion. Lubricate with a light oil.
2. Carefully check the armature for grounds or shorted turns. Refinish the commutator surface if pitted or excessively worn.
3. Check the brushes for wear. Ensure that they are free in the brush holders.

Note: Observe how the brushes are assembled in the brush holders and the position of the brush lead. New brushes must be installed in the same manner.

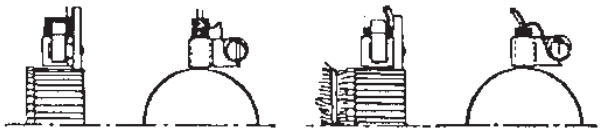
Remove old brushes and install new as follows:

a. Remove brush spring clip from its mounting on brush assembly.
b. Lift brush assembly from brush holder.
c. Disconnect brush assembly lead.
d. Install new brushes following the previous steps in reverse order.

4. Inspect the wire harness and all connections for signs of damage due to overheating.
5. Check the magnets on the stator to be sure they are securely mounted.

Reassembly

1. Install new brushes, making sure they are free in the holder and the lead wires are positioned as when disconnected. Raise all brushes to the locked position (figure 7.16).



Brushes raised with the springs in locked position on the side of the brush

Brushes and springs in their final position

Figure 7.16—Brush Installation

2. Place commutator cover on a work bench with brush assembly facing upward.
3. Place the bearing spring into the bearing bore.
4. Keeping the assembly in a vertical position, install new bearings on the armature shaft by pressing the inner race, moving the bearing into the proper position.
5. Align the armature assembly, including bearings, and insert the commutator end bearing into the bearing bore.
6. Set the brushes to the final position as shown in figure 7.16.
7. With the armature assembly secured in a vertical position, place the complete stator assembly down and securely into position on the commutator cover (see figure 7.17).

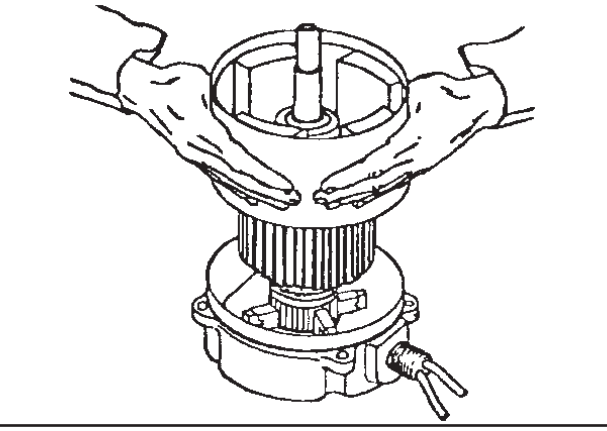


Figure 7.17—Assembly Procedure

Note: Be careful during this procedure. There is a strong magnetic attraction between the stator assembly and the armature. This tends to pull the stator assembly rapidly downward. It is important to have a firm grasp on the stator assembly, making sure fingers are free from the space between the assembly and commutator cover (figure 7.17).

8. Rotate the stator assembly until the match mark on its bottom lines up with the match mark on the commutator cover.

Note: It is important that the stator assembly is properly aligned.

9. Assemble the pulley end cover in the proper relationship. Insert the mounting bolts and tighten alternatively to ensure a good mechanical alignment.
10. Spin the shaft by hand to see if it is free. If the motor has leads, be sure they are not touching. If they are touching, a generator action will give the effect of friction in the motor.
11. Once the shaft is spinning freely, perform a "no-load" test. Connect an ammeter as shown on Figure 7.15. With the power connected and the motor running the ammeter should read less than 20% of the full-load current (from the nameplate). A higher reading indicates:
    a. Brushes are not on neutral setting (check match marks for exact alignment.
    b. Faulty armature.

Hydraulic Cylinders

All functions of lifting, steering, and braking are performed by hydraulic cylinders. Their routine inspection for proper operation is a vital part of maintenance procedures. See Chapter 3, Maintenance.

Steer and Brake Cylinder

The steer cylinder (figure 7.18) is mounted at the front of the chassis directly above the wheel motors.

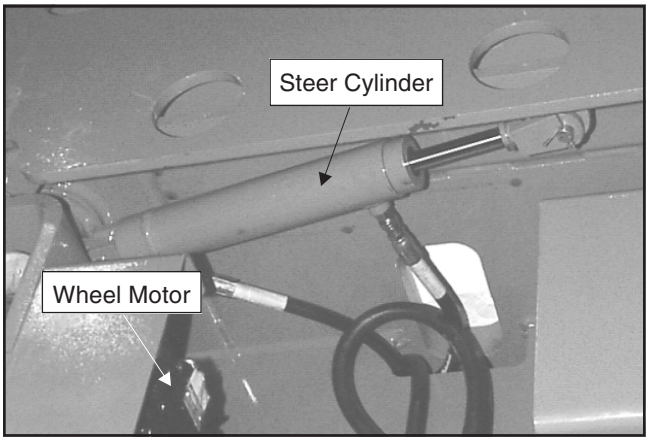


Figure 7.18—Steer Cylinder

The brake cylinder (figure 7.19) is mounted at the back of the chassis between the rear wheels.

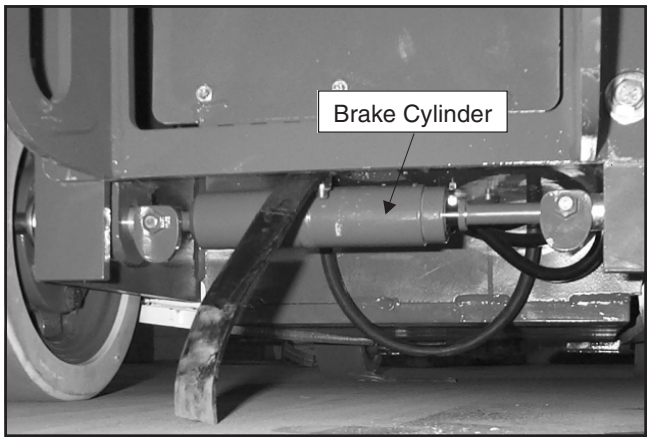


Figure 7.19—Brake Cylinder

Steer and Brake Cylinder Service

To properly disassemble and service a steer or brake cylinder the following equipment and supplies are required:

- Seal kit (part number in Parts Manual)
- Adjustable-face pin spanner wrench
- Pliers or vise-grip
- Bench vise with cushioned jaws
- Propane torch (possibly)
- Soft mallet
- New hydraulic fluid
- Cleaning solvent
- Power pack (hydraulic test pump)
- Locktite® 271 Threadlock
- Clean work bench

Disassembly

1. Wipe all dirt and grease from cylinder.
2. Secure the cylinder in a vise or other acceptable holding equipment. Use care to not damage the tube.
3. Remove the head gland retaining wire using an adjustable-face pin spanner wrench. Use the wrench to turn the retaining wire out through the slot in the outside of the tube. This should require one revolution. If you can turn the head gland but the retaining wire does not feed out of the slot, use a pliers or vise-grip to grab the end of the wire and pull as you turn the head gland.
4. Slide the rod assembly from the cylinder using care to not damage the rod (do not use pneumatic or hydraulic pressure to remove the rod assembly).
5. Fasten the rod end mount in a cushioned-jaw vise.

6. Remove the flange bolt from the rod assembly. It may be necessary to apply heat to break the sealant bond between the bolt and rod. The heat should be applied uniformly to a temperature of 300° to 400°F. Take care not to overheat the parts.
7. Remove the piston and head gland. Remove and discard all seals, taking care not to scratch the grooves.

Cleaning and Inspection

1. Inspect all load bearing welds for signs of fatigue or cracks. Replace weldments where necessary.
2. Thoroughly clean all components with solvent. All contaminates must be removed to assure proper operation of the cylinder.

⚠DANGER

Solvents present a potential flash fire hazard. Keep away from heat, sparks, or flame. Follow the manufacturer's label for proper use and disposal.

3. Inspect head gland and piston for damage. Repair any damage to seal grooves.
4. Replace all seals with lightly oiled new ones from the seal kit. The rod oil-seal lips face toward the inside of the cylinder. The rod wiper lip faces the outside of the cylinder. Take care to not damage the seals during their assembly.
5. Inspect the tube bore for scratches or scoring. Small scratches may be removed with a honing stone or very fine emery cloth. Large scratches or scoring cannot be repaired; the tube weldment should be replaced. Clean tube with solvent.
6. Inspect the cylinder rod for scratches or dents. Repair small scratches with a honing stone or very fine emery cloth. Large scratches or dents cannot be repaired and require replacement of the rod weldment. Clean the rod with solvent.

Assembly

1. Coat all components with a thin layer of new hydraulic fluid.
2. Carefully push the assembled head gland onto the rod. A soft mallet may be used to gently tap the gland.
3. Install the piston onto the rod. Apply Loctite® 271 threadlock to the bolt threads. Install the flange bolt into the rod and torque to 60-66 ft lb.
4. Lubricate the inside of the tube with clean hydraulic fluid. Line up the tube and rod center lines and push the rod assembly into the tube. As the piston enters the tube, gently push the piston seal past the retaining wire groove. Be careful to not damage the piston seal.
5. Insert the hooked end of the retaining wire into the hole in the head gland through the slot in the outside of the tube. Using an adjustable-face pin spanner wrench, turn the wire into the cylinder tube.

Testing

1. At the bench, attach a power pack (hydraulic test pump), adjusted for a maximum of 2800 psi (19,305 kPa), to the cylinder and power it through several cycles, checking for smooth operation. This will bleed all air from the cylinder. Release pressure.
2. Reinstall the cylinder following the removal procedure in reverse order.
3. Following reattachment to the machine, recycle the cylinder several times, checking for proper operation.

Lift Cylinder

Follow these procedures to remove and repair the lift cylinder.

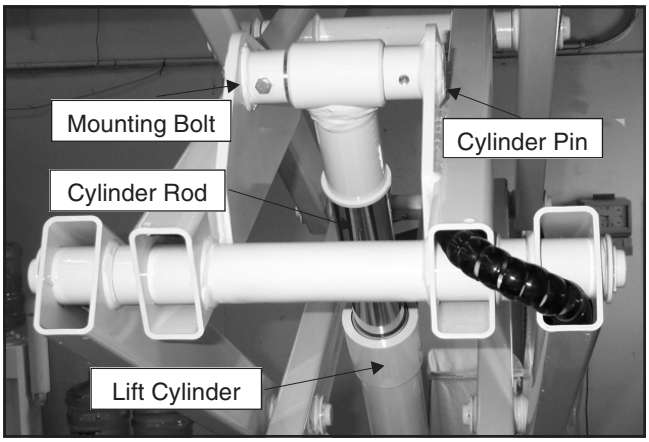


Figure 7.20—Lift Cylinder

⚠DANGER

Pinch points exist on the scissors structure. Death or serious injury can result if the scissors structure drops onto personnel working within the scissors arms or under the raised platform. Properly position the safety prop before detaching the lift cylinder.

Cylinder Removal

1. Raise the platform and properly position the safety prop. Lower the platform until the safety prop is securely in place and the weight of the platform is supported by it.
2. Activate the emergency bleed-down valve (figure 5.6, Chapter 5) at the front of the scissors assembly and keep it open until all pressure has been relieved from the cylinder.

⚠DANGER

Disassembling a pressurized cylinder is hazardous. Death or serious injury can result from sudden release of pressure. Make sure pressure is relieved prior to removing the cylinder from the machine.

3. At the upper end, remove the mounting bolt (figure 7.20) and use a hammer and punch to knock out the pin attaching the cylinder to the scissor assembly (figure 7.20).

4. With one person holding the cylinder end to prevent damage to the cylinder rod, retract the cylinder using the lower controls.

⚠CAUTION

Any dents, dings, or scratches in the cylinder rod can cause the cylinder to leak, potentially leading to cylinder failure. Take care to not damage it.

5. Disconnect the fluid hoses from the base of the cylinder. Cap the hoses and the ports to prevent contamination.
6. Remove the two mounting bolts from the base and knock out the pin. The cylinder should now be free.

Service Procedure

To properly disassemble and service the lift cylinder, the following equipment and supplies are required:

- Seal kit (part number in Parts Manual)
- Chain or pipe wrench
- Bench vise with cushioned jaws
- Soft mallet
- Hex wrenches
- New hydraulic fluid
- Cleaning solvent
- Power pack (hydraulic test pump)
- Clean work bench

Disassembly

1. Wipe all dirt and grease from the depressurized cylinder.
2. Secure the cylinder in a vise or other acceptable holding equipment. Use care to not damage the tube.
3. Remove the set screw from the outside of the head gland cap. Remove the head gland cap with a chain or pipe wrench.
4. Slide the rod assembly from the cylinder taking care to not damage the rod (do not use pneumatic or hydraulic pressure to remove rod assembly). As the rod is extracted from the tube, remove the halves of the piston guides.
5. Fasten the rod end mount in a cushioned-jawed vise.
6. Remove the head gland cap. Remove and discard all seals, taking care to not scratch the grooves.

Cleaning and Inspection

1. Inspect all load bearing welds for signs of fatigue or cracks. Replace weldments where necessary.
2. Thoroughly clean all components with solvent. All contaminates must be removed to assure proper operation of the cylinder.
3. Inspect the head gland and piston guides for damage. Repair any damage to seal grooves.
4. Replace all seals with lightly oiled new ones from the seal kit. The rod oil-seal lips face toward the inside of the cylinder. The rod wiper lip faces the outside of the cylinder. Take care to not damage the seals during their assembly.
5. Inspect the tube bore for scratches or scoring. Small scratches may be repaired with a honing stone or very fine emery cloth. Large scratches or scoring cannot be repaired; the tube weldment should be replaced. Clean tube with solvent.
6. Inspect the cylinder rod for scratches or dents. Repair small scratches with a honing stone or very fine emery cloth. Large scratches or dents cannot be repaired and require replacement of the rod weldment. Clean the rod with solvent.

⚠DANGER

Solvents present a potential flash fire hazard. Keep away from heat, sparks, and flame. Follow the manufacturer's label for proper use and disposal.

Assembly

1. Coat all components with a thin layer of new hydraulic fluid.
2. Carefully push the assembled head gland onto the rod. A soft mallet may be used to gently tap the gland. Take care to not damage the rod seal.
3. Lubricate the inside of the tube with clean hydraulic fluid. Line up the tube and rod center lines and gently push the rod assembly into the tube. Position the piston guide halves on the rod as the groove enters the tube.
4. Screw the head gland onto the tube weldment. Torque to 250-300 ft lb.
5. Insert set screw into the head gland cap and torque to 10-11 ft lb.

Testing

1. At the bench, connect a power pack (hydraulic test pump), adjusted for a maximum of 2800 psi (19,305 kPa), to the cylinder and power it through several cycles, checking for smooth operation. This will bleed all air from the cylinder. Relieve pressure.
2. Reinstall the cylinder following the removal procedure in reverse order.
3. Using the lower controls, cycle the platform lift-and-lower functions several times, watching for smooth operation.

Chapter 8. Troubleshooting

General Purpose Troubleshooting

The chart below lists a variety of potential malfunctions, listed by problem, followed by the diagnosis of probable cause and a recommended corrective action. When performing repair work on the machine, be sure to follow all safety guidelines outlined in this book. All maintenance and repairs must be performed by trained and authorized personnel.

Problem	Probable Cause	Corrective Action
All functions stop working	• Motor or pump failure	• Manually stow the machine and repair
	• Low hydraulic fluid level	• Check fluid level, add if necessary (use approved fluid only)
	• Blown fuse in lower control box	• Replace fuse
	• Electrical system malfunction	• Manually stow the unit and repair
Platform will not raise or lower from lower controls	• Control selector switch in upper control position	• Change to lower control
	• Battery switch is off	• Change to on
	• Emergency Stop switch engaged	• Pull button out to disengage
Upper controls will not function	• Control selector switch in lower control position	• Change to upper control
	• Battery switch is off	• Change to on
	• Emergency Stop button engaged	• Pull button out to disengage
Platform will not raise	• Platform load capacity exceeded	• Remove excess weight (see specifications)
Platform will not raise or lower from upper controls	• Drive/Lift selector in drive	• Change to lift
Platform will not raise and alarm is sounding	• Unit is not on sufficiently level surface	• Lower platform and move to level spot
	• Pothole skid prevented from lowering	• Check pothole skids for obstruction
Platform drifts downward	• Emergency bleed-down valve not properly disengaged	• Check lever, return to normal operating position
	• Leak or malfunction in the hydraulic system	• Manually stow the unit and repair
Platform will not lower	• Safety prop in place	• Stow prop
Platform extension will not extend	• Latch pin not removed	• Remove pin
Drive functions won't work	• Drive/Lift selector in lift	• Change to drive
	• Unit is not on sufficiently level surface	• Lower platform and move to level spot
	• Free-wheeling valve is open	• Fully close valve
	• Platform load capacity exceeded	• Remove excess weight (see specifications)
	• Low hydraulic pressure	• Manually stow the unit and repair
Drives in slow only	• Platform elevated above six feet	• For faster drive, platform must be lowered
Unit will not steer	• Joystick interlock switch not engaged	• Interlock switch must be engaged or steering switch will not function

Problem	Probable Cause	Corrective Action
Unit drives slowly or operates sluggishly	• Low battery voltage • Kink, leak, or damage to hydraulic system	• Charge batteries • Manually stow the machine and repair
Wheels won't turn when towing or pushing the unit	• Break pins engaged • Free-wheeling valve closed	• Use wrench to manually disengage brake release cam • Fully open the valve
No power to electrical outlet	• Power supply not plugged in at base • Ground fault circuit interrupter (GFCI) is tripped	• Check plug-in power outlet at rear of chassis • Push reset button on outlet
Lower control box fuse burns out continually	• Electrical system malfunction	• Manually stow the unit and repair
Brakes don't function	• Brake pins not engaged	• Manually engage brake pins using a wrench on the brake release cam, or the pins should automatically reset when the unit is driven
Ammeter (on charger) registers zero when battery charger is plugged in	• Not properly plugged in or defective power source • Blown fuse on battery charger	• Check power source outlet • Replace fuse

Electrical Function Diagnostics

These troubleshooting steps are designed to isolate specific malfunctions in the electrical system. All component reference numbers are found on the electrical schematics at the end of the chapter. The procedures require the use of a properly connected (black to ground, red to hot) voltmeter with the capacity to read a range of voltages up to 50. All electrical troubleshooting procedures should begin with the following basic checkpoints:

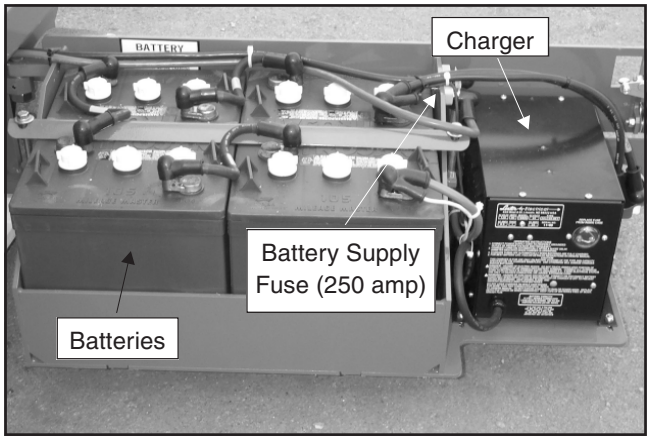


Figure 8.1—Battery Tray

- Check drive/lift selector (upper controls)
- Check emergency stop switch (upper and lower controls)
- Check control selector switch (lower controls)
- Check battery switch (figure 6.1, Chapter 6)
- Check battery voltage: 24V
- Check battery supply fuse (figure 8.1)
- Check lower control box fuse (figure 6.2, Chapter 6)

Pump Motor Not Running

A. Controller

1. Check voltage of wire 104 at the controller (figure 8.22). Is it 24 volts? If yes, go to 2. If no, see Limit Switches and Level Sensor (unless you have already performed that procedure. In that case, go to 2).

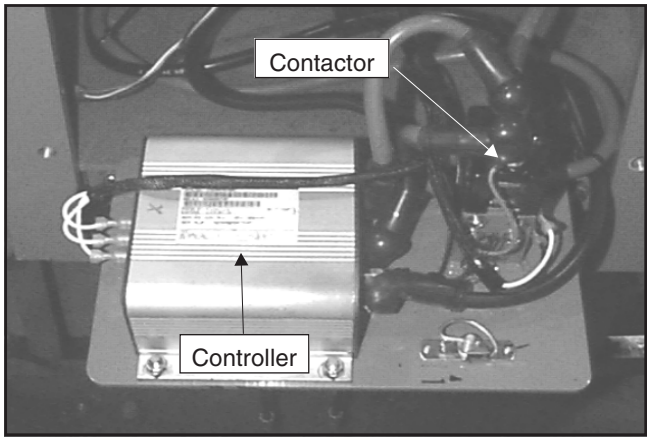


Figure 8.2—Motor Controller and Contactor

2. Check voltage of wire 110 at the controller (figure 8.22). Is it 4 to 5 volts? If yes, go to 3. If no, check ground and positive terminals on controller (B- and B+). Make sure connections are good and cables OK.
3. Check voltage of wire 101 to controller (with both emergency stops pulled out and joystick control set to neutral). Is it 2 to 3volts? If yes, go to B, Contactor. If no, check joystick potentiometer (figure 8.13). If you cannot get any voltage on wire 101, or it is the incorrect voltage, call Snorkel technical service for additional help.

B. Contactor

1. From the lower control, activate platform lift while watching and listening to see that the contactor closes (Figure 8.2). If yes, go to C, Pump Motor. If no, go to 2.
2. Check terminals on contactor (under rubber boots) for proper connections. If yes go to 3. If no, secure the connections.
3. Check wire 207 on the side tabs of the contactor (figure 8.22) while activating a machine function. Is it 24 volts? If yes, go to 4. If no, replace wire.
4. Check continuity of ground wire 3M (next to 207) to the B- connection on the controller. Continuity OK? If yes, go to 5. If no, check and/or replace wire 3M.
5. Check contactor diode (figure 8.23) to insure it is oriented and seated correctly. If yes, go to C, Pump Motor. If no, seat or replace diode.
6. Repeat step one. If contactor closes, go to C, Pump Motor. If no, replace contactor.

C. Pump Motor

1. Check voltage of the positive battery connection at the motor while activating a machine function. Is it 24 volts? If yes, go to 2. If no, check contactor connections and cable between contactor (K5) and pump motor.
2. Check negative cable from motor to controller. Connections OK? If yes, go to 3. If no, tighten connections or replace cable.
3. Check voltage at the positive and negative motor connections. Approximately 12 volts (while steering) or 21 volts (while driving in high or lifting)? If yes, go to 4. If no, inspect and/or replace controller.
4. Check hydraulic pump and motor (figure 7.14, Chapter 7) for free movement. If no, check and/or replace pump or motor (Chapter 7).

No Lift From Lower Controls

1. Check connection of upper control box to the stack wiring harness. Connections OK? If yes, go to 2. If no, reconnect the harness.
2. Check voltage on wire 116. Is it 24 volts? If yes, go to 3. If no, check 20 amp control box fuse (fig. 6.2, Chapter 6).
3. Check voltage on wire 102. Is it 24 volts? If yes, go to 4. If no, check emergency stop.
4. Check voltage on wire 113. Is it 24 volts? If yes, go to 5. If no, check lower/upper selector switch.
5. Check voltage on wire 22 at lift solenoid (figure 7.13, Chapter 7). Is it 24 volts? If yes, go to 6. If no, check and/or replace wire 22.
6. Check lift solenoid and ground wire at solenoid. If grounded and solenoid is OK, go to 7. If not, replace wire and/or solenoid.
7. Check K4 relay (figure 8.9) and wire 208. Any voltage present? If yes, go to 8. If no, K-4 relay is activated. In this event, contact Snorkel technical service for additional help.
8. Check R2 and R5 resistors (figure 8.9). Seated properly? If yes, go to 9. If no, reconnect.
9. Check each resistor with voltmeter. R2 should read 3.3 K ohms. R5 should read 680 ohms. If yes, go to 10. If no replace resistor(s).
10. Check wire 122 in the platform box. Is it 2-3 volts? If yes, go to 11. If no, replace wire.
11. Check wire 101 at controller (figure 8.22). Is it 2 to 3 volts? If yes, go to 12. If no, replace wire.
12. Is the pump motor running? If yes, see Hydraulic Troubleshooting. If no, see Pump Motor Not Running.

No Lift or Drive From Upper Controls

1. Pull out emergency stop at lower controls.
2. Check voltage on wire 2 at upper emergency stop switch. Is it 24 volts? If yes, go to 3. If no, check upper/lower and emergency stop switches to lower controls.
3. Check voltage on wire 114 to joystick control switch. Is it 24 volts? If yes, go to 4. If no, check wire and emergency stop.
4. Check voltage on wire 115 to micro-switches. Is it 24 volts? If yes, go to Lift, Drive, or Steer. If no, inspect and/or replace wire or micro-switch 30 (figure 8.14).

A. Lift

1. Perform steps 1-4 above (No Lift or Drive from Upper Controls).
2. Check voltage on wire 126 to drive/lift selector. Is it 24 volts? If yes, go to 3. If no, inspect and/or replace wire or micro-switch 18 (figure 8.14).
3. Check voltage on wire 222 from drive/lift selector to wire 22. Is it 24 volts? If yes, go to 4. If no, inspect and/or replace wiring or drive/lift selector.

4. Check voltage on wire 22 at lift solenoid (figure 7.13, Chapter 7). Is it 24 volts? If yes, go to 5. If no, check wire 22.
5. Check lift solenoid and ground wire at solenoid. If grounded and solenoid is OK go to 6. If not, replace wire and/or solenoid.
6. Is the pump motor running? If yes, see Hydraulic Troubleshooting. If no, see Pump Motor Not Running.

B. Drive

1. Perform steps 1-4 at No Lift or Drive from Upper Controls.
2. Check voltage on wire 125 (forward) or 126 (reverse). Is it 24 volts? If yes, go to 3. If no, inspect and /or replace wire or micro switch(es) 17 (forward) or 18 (reverse) (figure 8.14).
3. Check voltage at 17 forward solenoid or 18 reverse solenoid (figure 7.13, Chapter 7). Is it 24 volts? If yes, go to 4. If no, check wire 17 or 18.
4. Check solenoids and ground wires at both solenoids. If grounded and solenoids OK, go to 5. If not, replace wire(s) and/or solenoid(s).
5. Is the pump motor running? If yes, see Hydraulic Troubleshooting. If no, see Pump Motor Not Running.

No High-Speed Drive

1. Perform steps 1 through 7 under A. Scissor Switch. Once complete, continue to 2.
2. Check voltage on wire 17 at the forward drive solenoid (figure 7.13, Chapter 7). Is it 24 volts? If yes, go to 2. If no, see No Lift or Drive from Upper Controls.
3. Check switch number 17A (figure 8.14). Is it open? If yes, go to 4. If no, inspect and/or replace switch.
4. Check voltage of wire 101 while the machine is driving forward. Is it 3 to 4 volts? If yes, see Pump Motor Not Running. If no, adjust or replace joystick potentiometer at upper control box (figure 8.14).

No Low-Speed Drive

1. Raise platform and secure safety prop.
2. Check voltage on wire 121. Is it 1.1 to 1.4 volts? If yes, go to 4 (skip 3). If no, go to 3.
3. If voltage is below 1.1 volts, adjust drive speed potentiometer (figure 6.2, Chapter 6) until voltage reads 1.1 to 1.4 volts. Go to 4. If the measurement is 4 to 5 volts, K1, K3, or both relays are activated. In this event, call Snorkel technical service.
4. Check joystick switches SW18A and SW17A (figure 8.14). Operating OK? If yes, go to 5. If no, inspect and/or replace switch(es).
5. Check, inspect, and adjust joystick potentiometer (figure 8.13). Low-speed drive restored? If no, replace potentiometer and go to 6.
6. Low-speed drive restored? If no, call Snorkel technical service for additional help.

Incorrect Lift Speed

1. Check voltage on wire 22 at the lift solenoid (figure 7.13, Chapter 7). Is it 24 volts? If yes, go to 2. If no, go to Lift or Drive from Upper Controls.
2. Raise platform and secure safety prop (it will be necessary to have access to the upper controls during these procedures).
3. Remove wire 22 from lift solenoid (figure 7.13, Chapter 7).
4. Using the upper controls, put the lift/drive switch in lift and pull joystick back for full lift (this procedure is necessary for steps 5-8).
5. Check voltage on wire 121 at K3 relay (figure 8.9). Is it 4 to 5 volts? If yes, go to 7 (skip 6). If no, check voltage on wire 110 at controller (figure 8.22). Is it 4 to 5 volts? If yes, go to 6. If no go to Pump Motor Not Running.
6. Check ground wire of K3 relay. If grounded, replace relay and return to 5. If not grounded, check or replace ground wires and return to 5.
7. Check switch number 18A (figure 8.14). Is it open? If yes, go to 8. If no, inspect and/or replace switch.
8. Check voltage of wire 101. Is it 3 to 4 volts? If yes, see Pump Motor Not Running. If no, adjust or replace joystick potentiometer at upper control box (figure 8.13).
9. Reattach wire 22 to lift solenoid.

No Right or Left Steering

1. Perform steps 1-4 under No Lift or Drive From Upper Controls.
2. Check voltage on wire 19 (left) or 20 (right) at the steer solenoids (figure 7.13, Chapter 7). Is it 24 volts? If yes, go to 3. If no, inspect and/or replace wire 19 or 20 or switch 19 or 20 on joystick.
3. Perform steps 7 through 12 under No Lift From Lower Controls.

Limit Switches and Level Sensor

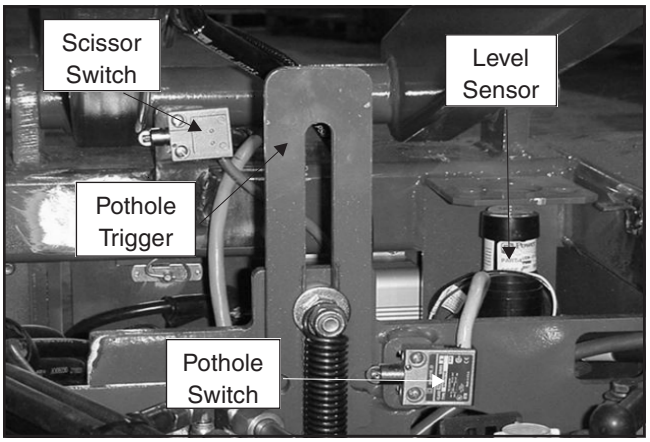


Figure 8.3—Switches and Sensor

A. Scissor Switch

1. Lower and stow the platform.
2. Pull out emergency stop at lower controls.
3. Check voltage on wire 102 to scissor switch (figure 8.3). Is it 24 volts? If yes, go to 4. If no, inspect and/or replace wire.
4. Check voltage on wire 106 to K1 relay (figure 8.9) at scissor switch. Is it 24 volts? If yes, go to 5. If no, inspect and/or replace scissors switch.
5. Check voltage on wire 121 at K1 relay. Is it 4 to 5 volts? If yes, go to 7 (skip 6). If no, check voltage on wire 110 at controller (figure 8.22). Is it 4 to 5 volts? If yes, go to 6. If no, go to Pump Motor Not Running.
6. Check ground wire of K1 relay. Properly grounded? If yes, replace relay and return to 5. If not, check and/or replace ground wire and return to 5.
7. Check voltage on wire 111 to K2 relay (figure 8.9). Is it 24 volts? If yes, go to B. Pothole Switch and Level Sensor. If no, replace D1 diode (figure 8.9) and go to B.

B. Pothole Switch and Level Sensor

1. Raise platform and secure the safety prop.
2. Pull out emergency stop at lower controls.
3. Check voltage on wire 102 to pothole switch (figure 8.3). Is it 24 volts? If yes, go to 4. If no, inspect and/or replace wire.
4. Check voltage on wire 112 from pothole switch to level sensor (figure 8.3). Is it 24 volts? If yes, go to 5. If no, inspect and/or replace pothole switch.
5. Check voltage on wire 111 from level sensor to K2 relay (figure 8.9). Is it 24 volts? If yes, go to 6. If no, inspect and/or replace wiring and level sensor.
6. Check voltage on wire 106 to K1 relay (figure 8.8). If no voltage, go to 7. If any voltage is present (1 to 24 volts), replace diode D1 (figure 8.9) and continue to 7.
7. Check voltage on wire 104 at controller (figure 8.22). Is it 24 volts? If yes, see Pump Motor Not Running. If no, check ground of K2 relay. If properly grounded, replace relay. If not grounded, check ground wire.

Hydraulic Function Diagnostics

These troubleshooting steps are designed to isolate specific malfunctions in the hydraulic system. All component reference numbers are found on the hydraulic and electrical schematics at the end of the chapter. The procedures require the use of a pressure gauge with the capacity to measure 3000+ PSI and a flow meter.

Lift

1. Raise platform and secure safety prop.
2. Check 2H-9 up valve (wire 22). Activating properly? If yes, go to 3. If no check and/or replace valve.
3. Check emergency bleed-down valve (figure 5.6, Chapter 5). Activated? If no, go to 4. If yes, repair or replace valve.
4. Check R-3 lift relief valve (figure 7.12, Chapter 7). Is it 2500 PSI? If yes, go to 5. If no, check R-1 system relief valve (figure 7.13, Chapter 7). Is it 2800 PSI? If yes, adjust R-3 lift relief valve to 2500 PSI. If no, adjust R-1 system relief valve to 2800 PSI or inspect hydraulic pump (figure 7.14, Chapter 7).
5. Inspect flow control valve at lift cylinder. Operating properly? If yes, go to 6. If no, repair or replace valve.
6. Inspect lift cylinder (see procedure in Chapter 7, Hydraulic System).

Lower

1. Raise platform and secure safety prop.
2. Check 2H-11 lowering valve (wire 21). Activating properly? If yes, go to 3. If no, inspect and/or replace wire and valve.
3. Check the down orifice (next to the check valve on the lift cylinder.) Operating properly? If yes, go to 4. If no, repair or replace orifice.
4. Check 2H-9 up valve. Deactivated? If no, repair or replace valve.

Forward Drive

1. Check 4H-8 forward drive valve solenoid and cartridge. Operating properly? If yes, go to 2. If no, check and/or replace wiring and/or solenoid.
2. Check V-3 free wheeling valve (figure 7.11, Chapter 7). Closed? If yes, go to 3. If no, close or replace (if defective).

3. Check brake cylinder (figure 7.19, Chapter 7). Releasing properly? If yes, go to 4. If no, check brake shuttle and V-2 metering valve. Operating properly? If yes, inspect brake cylinder (see procedure in Chapter 7, Hydraulic System). If no, repair or replace shuttle or valve.
4. Check hydraulic pressure to wheel drive motors. Is it 2800 PSI? If yes, go to 5. If no, check and adjust R-1 system relief valve (figure 7.13, chapter 7) to 2800PSI.
5. Check CB-1 and CB-2 counter balance valves (figure 7.10, Chapter 7). Operating properly? If yes, go to 6. If no, replace defective valve(s).
6. Inspect, and/or repair or replace drive motors (see procedure in chapter 4, Base Frame Assembly).

Reverse Drive

1. Check 4H-10 reverse drive valve solenoid and cartridge. Operating properly? If yes, go to 2. If no, check and/or replace wiring and/or solenoid.
2. Check V-3 free wheeling valve (figure 7.11, Chapter 7). Closed? If yes, go to 3. If no, close or replace (if defective).
3. Check brake cylinder (figure 7.19, Chapter 7). Releasing properly? If yes, go to 4. If no, check brake shuttle and V-2 metering valve. Operating properly? If yes, inspect brake cylinder (see procedure in Chapter 7, Hydraulic System). If no, repair or replace shuttle and/or valve.
4. Check hydraulic pressure to wheel drive motors. Is it 2800 PSI? If yes, go to 5. If no, check and adjust R-1 system relief valve to 2800PSI.
5. Check CB-1and CB-2 counter balance valves (figure 7.10, Chapter 7). Operating properly? If yes to 6. If no, replace defective valve(s).
6. Inspect, and/or repair or replace drive motors (see procedure in Chapter 4, Base Frame Assembly).

Left Steering

1. Check 4H-1 left steer valve solenoid (figure 7.10, Chapter 7), wire 19. Operating properly? If yes, go to 2. If no, check and/or replace wiring and/or valve.
2. Check FC-1 steering flow control valve. Is it .50 G.P.M.? If yes, go to 3. If no, repair or replace valve.
3. Check R-2 steer relief valve. Is it 1500 PSI? If yes, go to 4. If no, adjust, repair, or replace valve.
4. Inspect steer cylinder and linkage (see procedure in Chapter 7, Hydraulic System. Repair or replace if defective.

Right Steering

1. Check 4H-2 right steer valve solenoid (figure 7.10, Chapter 7), wire 20. Operating properly? If yes, go to 2. If no, check and/or replace wiring and/or valve.
2. Check FC-1 steering flow control valve. Is it .50 G.P.M.? If yes, go to 3. If no, repair or replace valve.
3. Check R-2 steer relief valve. Is it 1500 PSI? If yes, go to 4. If no, adjust, repair, or replace valve.
4. Inspect steer cylinder and linkage (see procedure in Chapter 7, Hydraulic System. Repair or replace if defective.

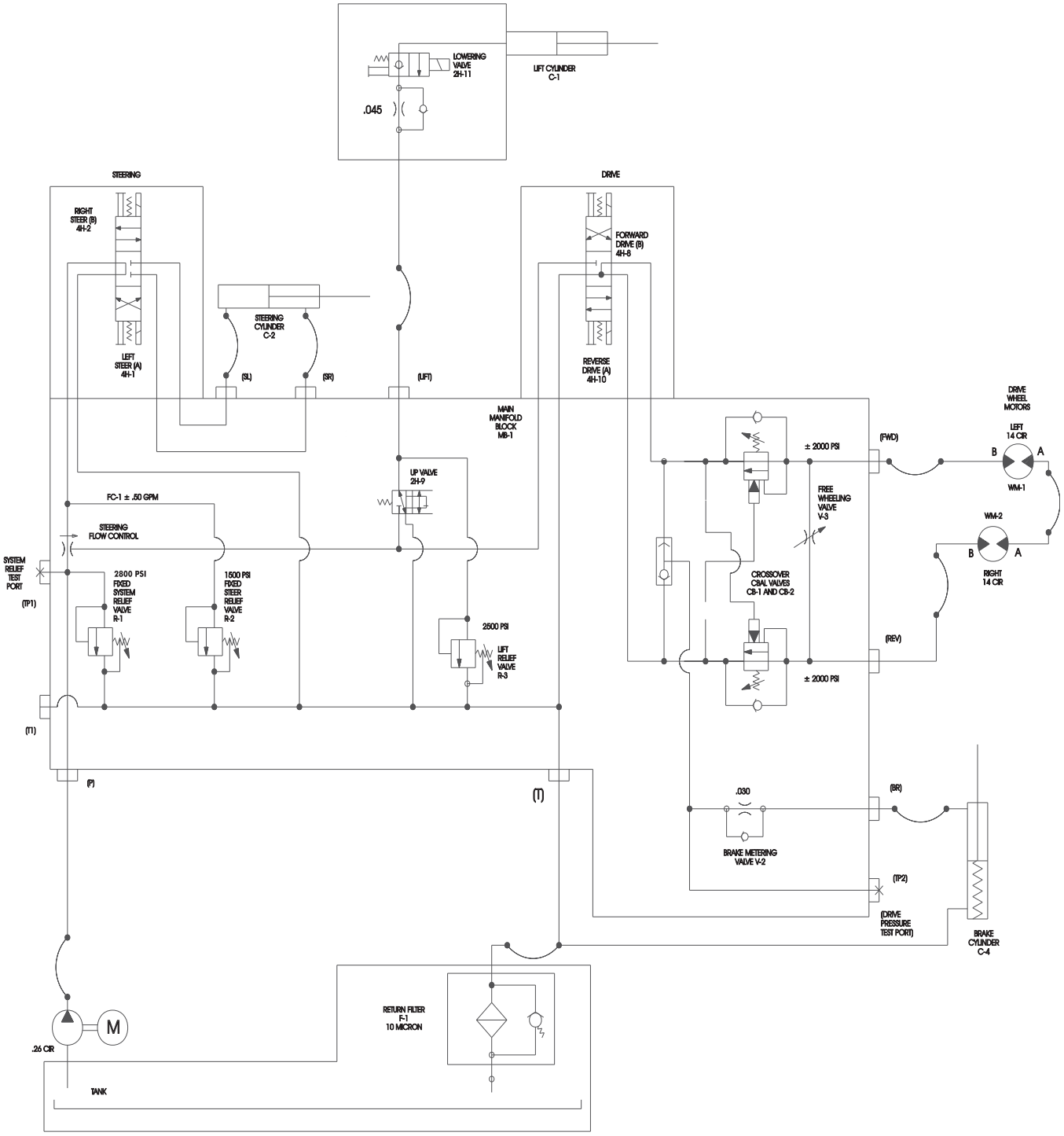


Figure 8.4—Hydraulic Schematic

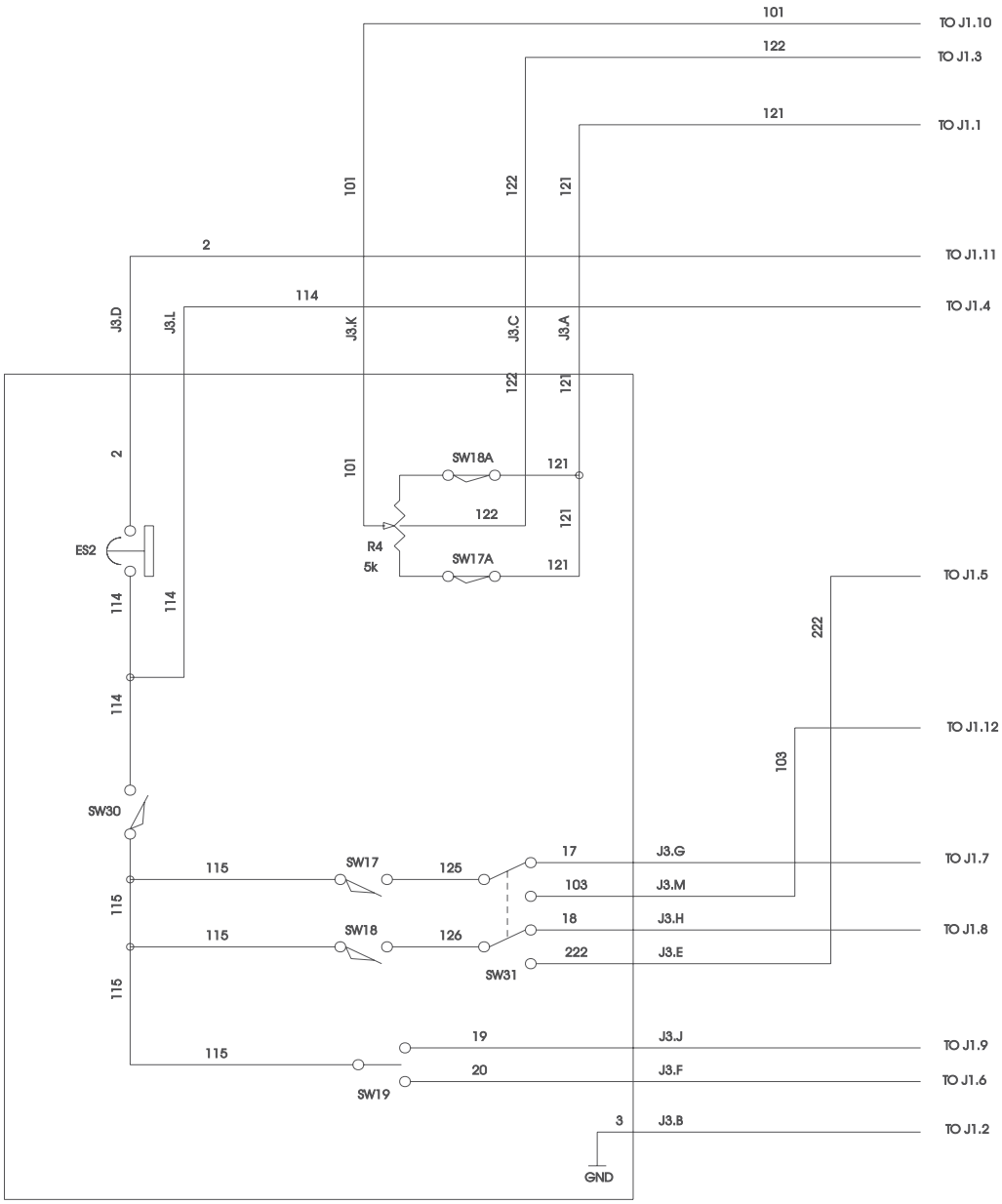


Figure 8.5—Upper Control Box Electrical Schematic

#	Component	#	Component	#	Component	#	Component
A	Motion alarm	D13	Diode	K5	Contactor relay	SW1	Lower/upper control selector switch
B	Battery	D•	Diode in harness or on device	M	Motor	SW16	Tilt sensor
D1	Diode	DSW	Disconnect switch	PWM	Pump controller	SW17	Forward/down joystick switch
D2	Diode	ES1	Lower control e-stop	R1	Low-speed variable resistor	SW17A	Joystick switch opens/5k var. resistor
D3	Diode	ES2	Upper control e-stop	R2	Turning resistor	SW18	Reverse/lift joystick switch
D4	Diode	FU1	Main system fuse	R3	Low-speed resistor	SW18A	Joystick switch opens/5k var. resistor
D5	Diode	FU2	Controls fuse	R4	Joystick variable resistor	SW19	Left steer joystick switch
D6	Diode	HM	Hourmeter	R5	Joystick threshold resistor	SW20	Right steer joystick switch
D7	Diode	J1	Overload jumper	SOL17	Forward drive valve	SW22	Lower control lift/down switch
D8	Diode	J2	CE lowering circuit jumper	SOL18	Reverse drive valve	SW30	Joystick handle switch
D9	Diode	K1	High-speed relay	SOL19	Left steer valve	SW31	Upper control drive/lift selector switch
D10	Diode	K2	Tilt relay	SOL20	Right steer valve	SW32	Stack switch
D11	Diode	K3	Lift relay	SOL21	Down valve	SW33	Pothole switch
D12	Diode	K4	Drive speed relay	SOL22	Lift valve		

Figure 8.6—Electrical Components

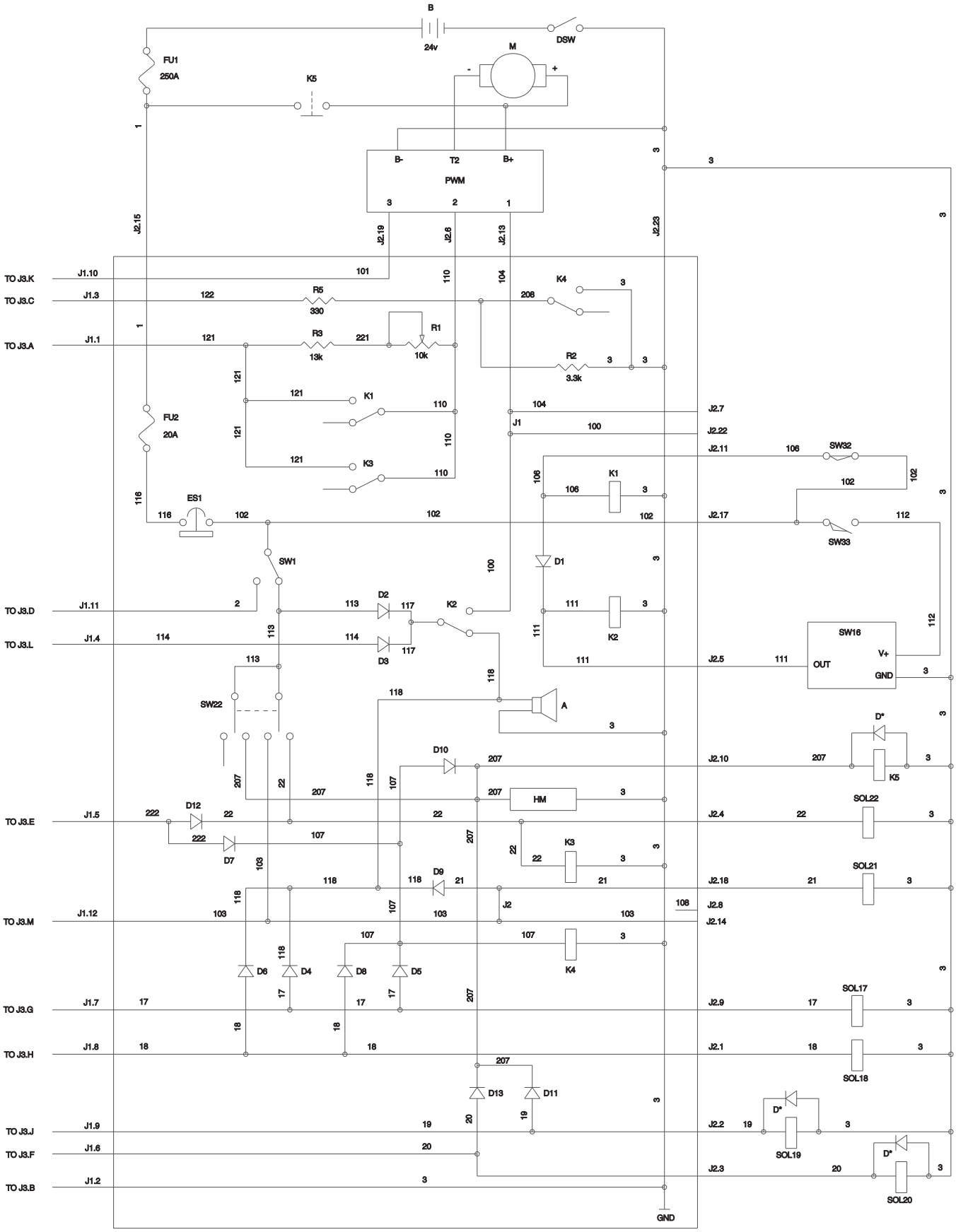


Figure 8.7—Lower Control Box Electrical Schematic

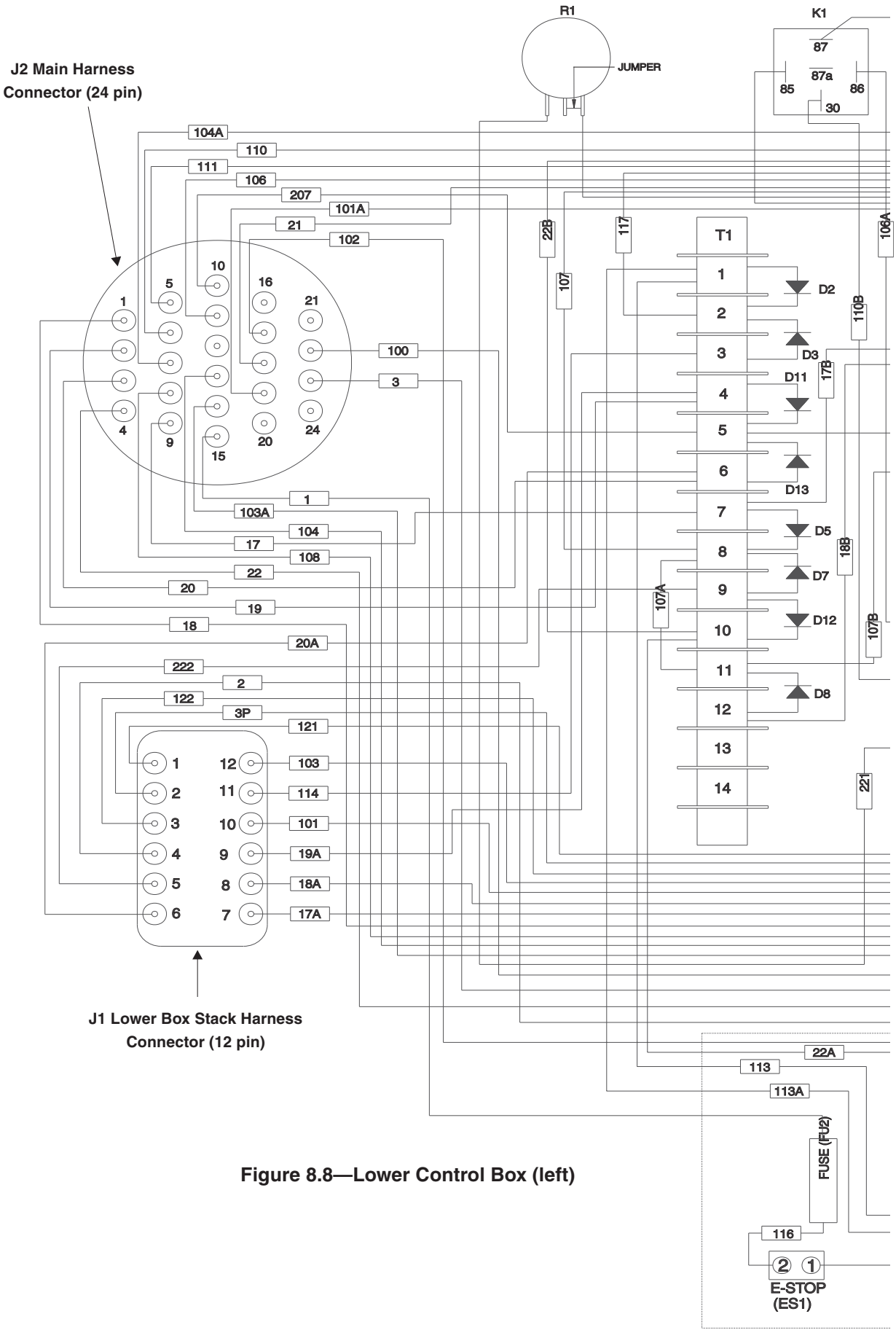


Figure 8.8—Lower Control Box (left)

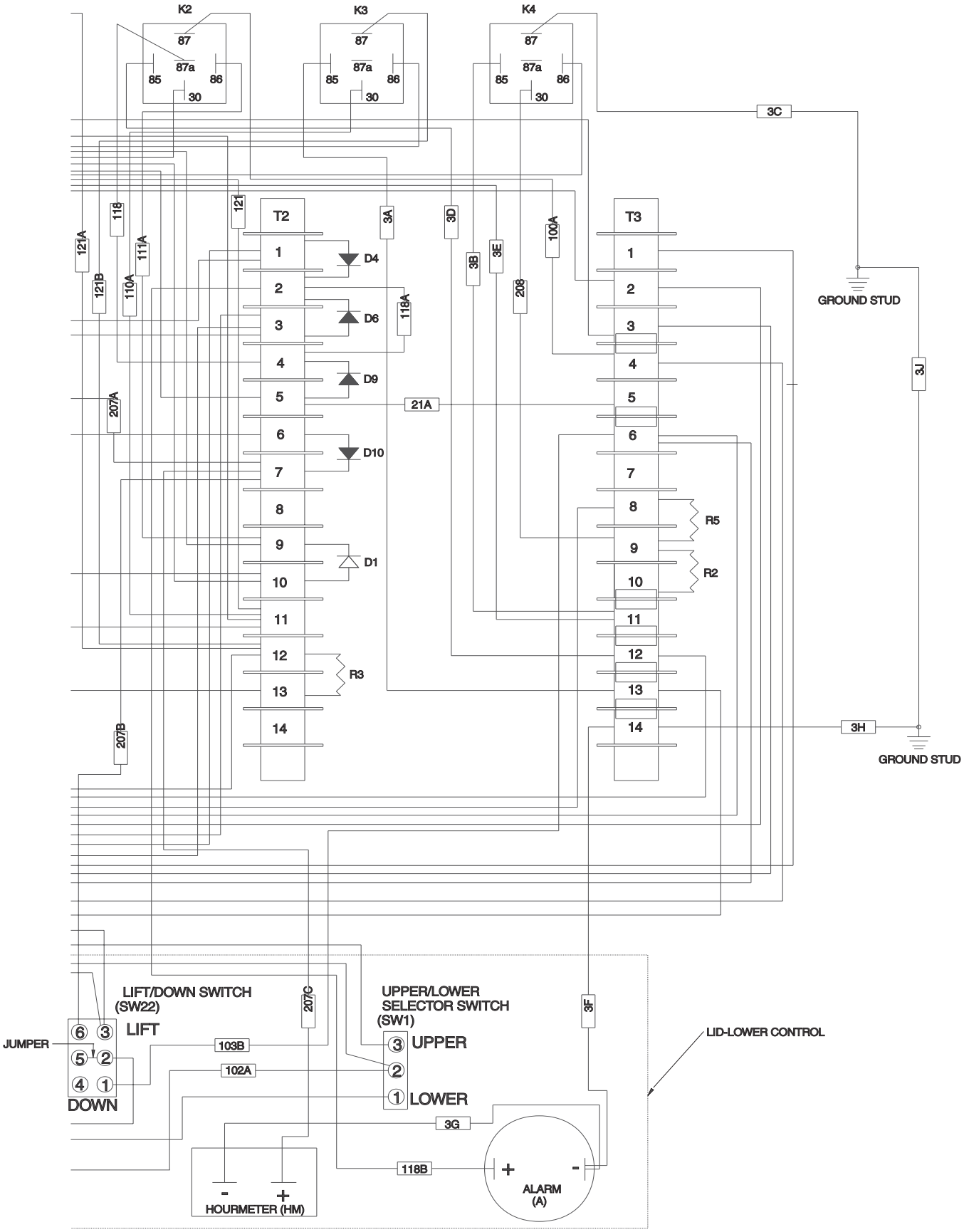


Figure 8.9—Lower Control Box (right)

Lower Control Box

#	Description
A	Motion alarm
ES1	Lower control e-stop
FU2	Controls fuse
HM	Hourmeter
J1	Overload jumper
J2	CE lowering circuit jumper
K1	High speed relay
K2	Tilt relay
K3	Lift relay
K4	Drive speed relay
R1	Low speed variable resistor
R2	Turning resistor
R3	Low speed resistor
R5	Joystick threshold resistor
SW1	Lower/upper control selector switch
SW22	Lift/down lower control switch

Figure 8.10—Lower Control Box Components

Position	Description	Wire
1	Potentiometer resistors	121
2	Ground	3P
3	Center tap	122
4	Power	2
5	Platform lift	222
6	Right steer	20A
7	Forward drive	17A
8	Reverse drive	18A
9	Left steer	19A
10	Joystick output	101
11	Return power to lower control box	114
12	Platform down	103

Figure 8.11—J1 Lower Box Stack Harness Connector

Position	Description	Wire
1	Reverse drive valve	18
2	Left steer valve	19
3	Right steer valve	20
4	Lift valve	22
5	From tilt sensor	111
6	Output voltage controller	110
7	From pressure switch	104A
8	From lowering interrupt switch	108
9	Forward drive valve	17
10	Contactor	207
11	From stack switch	106
12	Spare	plug
13	Controller	104
14	Lowering interrupt switch	103A
15	Battery positive	1
16	Spare	plug
17	Pothole stack switch	102
18	Down valve	21
19	Controller signal	101A
20	Spare	plug
21	Spare	plug
22	Pressure switch	100
23	Ground	3
24	Spare	plug

Figure 8.12—J2 Main Harness Connector

Item	Joystick Component	Qty
1	Handle	1
2	Mounting screw	2
3	Nylon washer	2
4	Gasket	1
5	Boot	1
6	Pot plate	1
7	Casting	1
8	Screw	2
9	Spacer	2
10	Cam	1
11	Screw	2
12	Cam	1
13	Micro switch	4
14	Tywrap	11
15	Connector	1
16	Pin	10
17	Micros assembly	1
18	Potentiometer assembly	1
19	Handle	1
20	Set screw	1

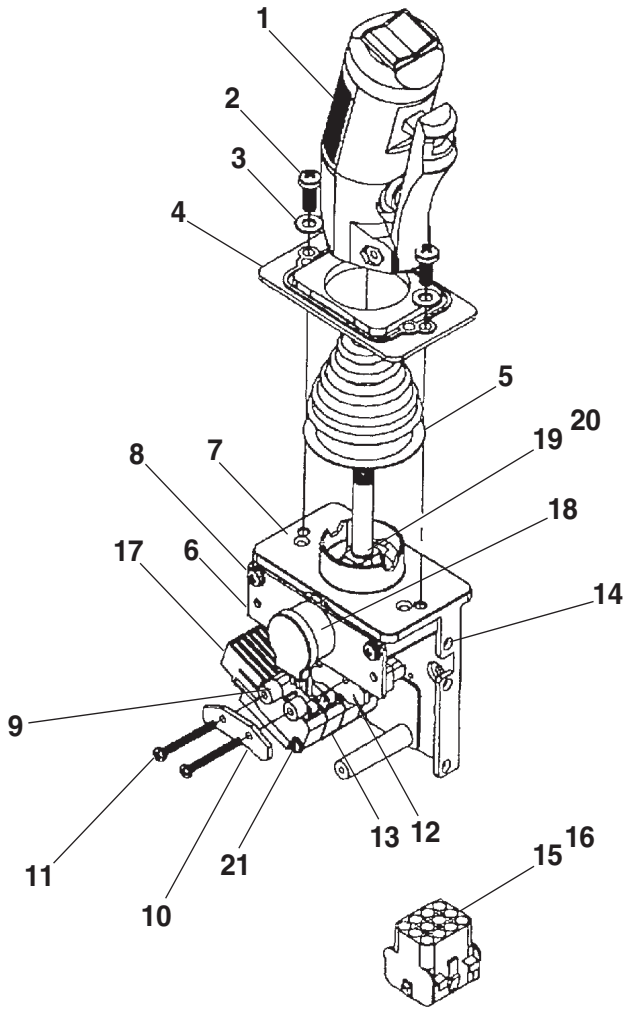


Figure 8.13—Joystick Components

Wire	Color	Description	From	To
19	White/red	Steer left	SW19-NO	AMP-1
20	White	Steer right	SW20-NO	AMP-3
101	Green	Output from joystick	POT-W	AMP-9
114A	White/black	Power to joystick	AMP-2	SW30-C
115	White/blue	Power to forward/reverse switches	SW30-NO	SW17-C, SW18-C, & AMP-8
115A	White/green	Power to thumb steer	SW30-NO	SW19-C, SW20-C, & AMP-5
121	Blue	Potentiometer resister	AMP-6	SW18A-C, & SW17A-C
122	Gray	Center tap	AMP-10	POT-T
125	Yellow	Forward/down	SW17-NO	AMP-4
126	Brown	Reverse/lift	SW18-NO	AMP-7
209	Violet	Potentiometer to switch	POT-CCW	SW18A-NC
210	Orange	Potentiometer to switch	POT-CW	SW17A-NC
NO: normally open, NC: normally closed, C: common				

Figure 8.14—Joystick Internal Wiring

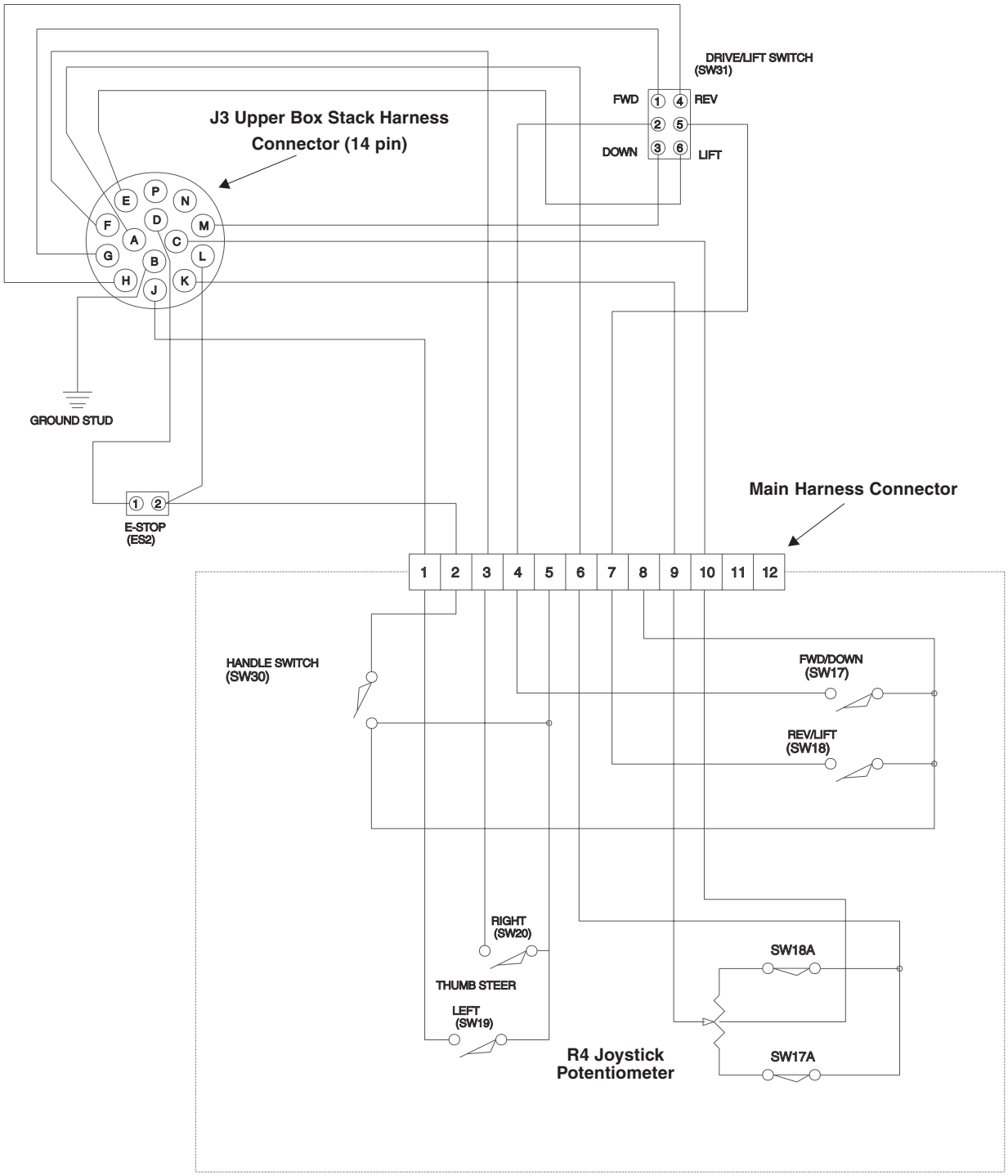


Figure 8.15—Upper Control Box

Upper Control Box

Position	Description	Wire
1	Steer left	19
2	Power to joystick	114A
3	Steer right	20
4	Forward/down	125
5	Spare	
6	Potentiometer resister	121
7	Reverse/lift	126
8	Spare	
9	Output from joystick	101
10	Center tap	122
11	Spare	
12	Spare	

Figure 8.16—Main Harness Connector (Non-Joystick Side)

Position	Description	Wire
A	Potentiometer resistor	121
B	Ground	3P
C	Center tap	122
D	Power	2
E	Platform lift	222
F	Right steer	20
G	Forward drive	17
H	Reverse drive	18
J	Left steer	19
K	Output from joystick	101
L	Power return to lower control box	114
M	Platform down	103
N	Spare	Plug
P	Spare	Plug

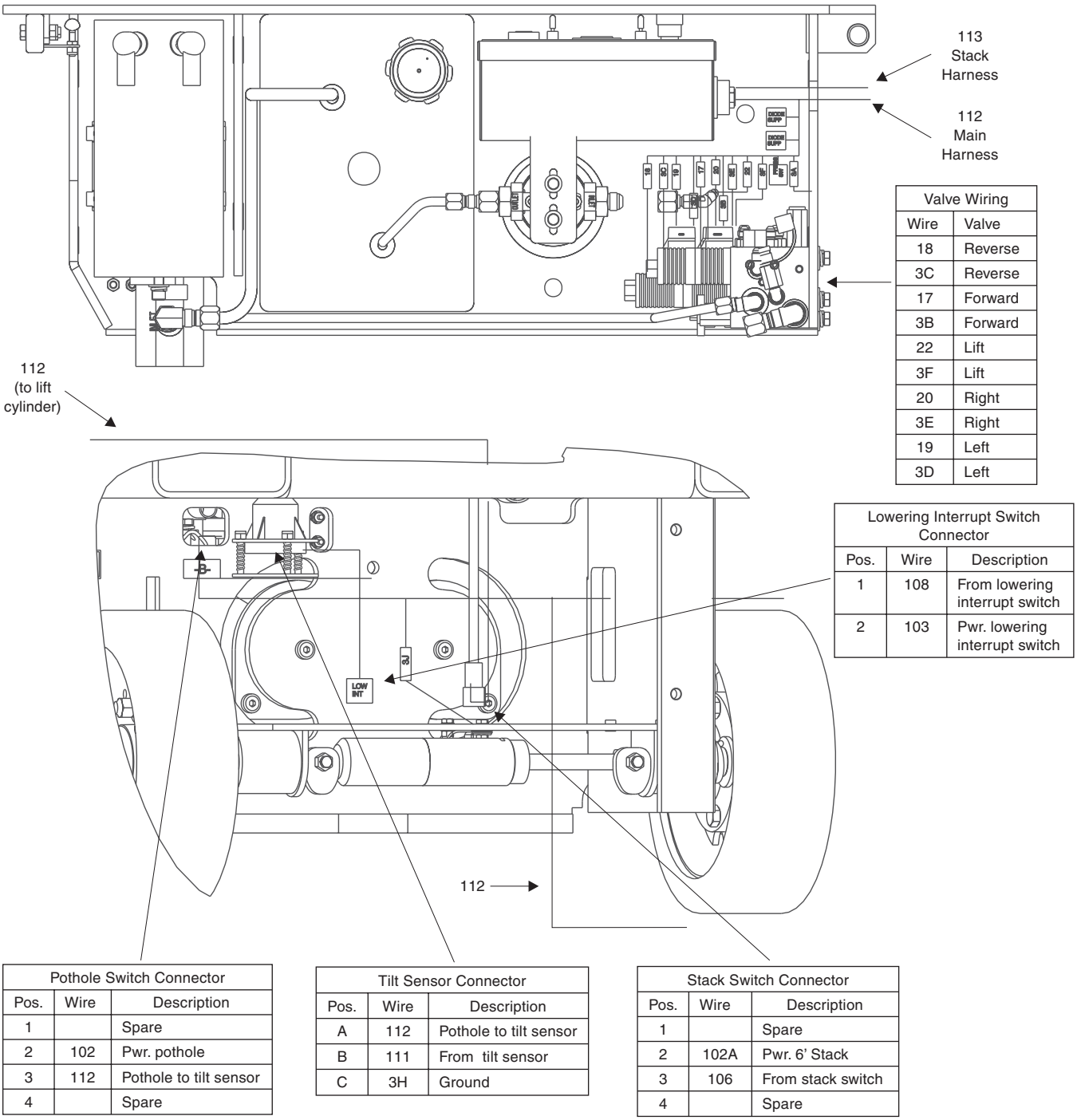
Figure 8.18—Upper Box Stack Harness Connector

Position	Description	Wire
1	Forward drive	17
2	Forward/down	125
3	Platform down	103
4	Reverse drive	18
5	Reverse/lift	126
6	Platform lift	222

Figure 8.17—Drive/Lift Switch

Position	Description	Wire
1	Power	2
2	Power return to lower control box	114
2	Power to joystick	114A

Figure 8.19—E-Stop



Valve Wiring	
Wire	Valve
18	Reverse
3C	Reverse
17	Forward
3B	Forward
22	Lift
3F	Lift
20	Right
3E	Right
19	Left
3D	Left

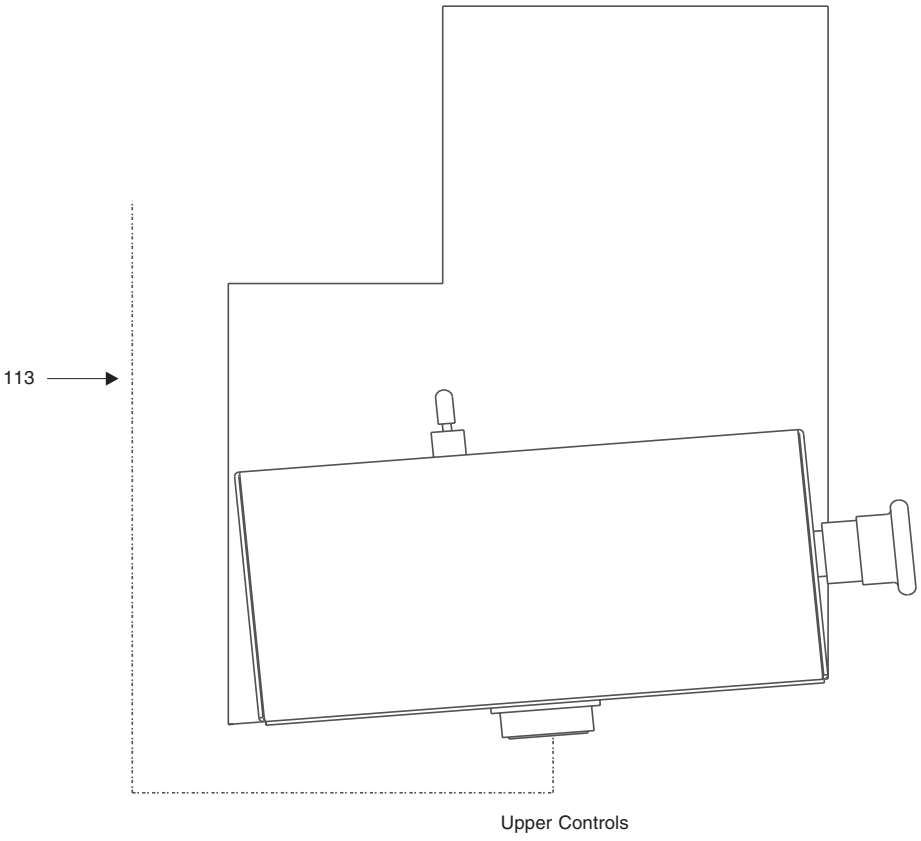
Lowering Interrupt Switch Connector		
Pos.	Wire	Description
1	108	From lowering interrupt switch
2	103	Pwr. lowering interrupt switch

Pothole Switch Connector		
Pos.	Wire	Description
1		Spare
2	102	Pwr. pothole
3	112	Pothole to tilt sensor
4		Spare

Tilt Sensor Connector		
Pos.	Wire	Description
A	112	Pothole to tilt sensor
B	111	From tilt sensor
C	3H	Ground

Stack Switch Connector		
Pos.	Wire	Description
1		Spare
2	102A	Pwr. 6' Stack
3	106	From stack switch
4		Spare

Figure 8.20—Wiring Harnesses Connections (left)



#	Terminal
1	Power input (24V)
2	Power output (5V)
3	Joystick signal input
B+	Battery positive
T2	Motor control negative
B-	Battery ground

Figure 8.21—Controller Terminals

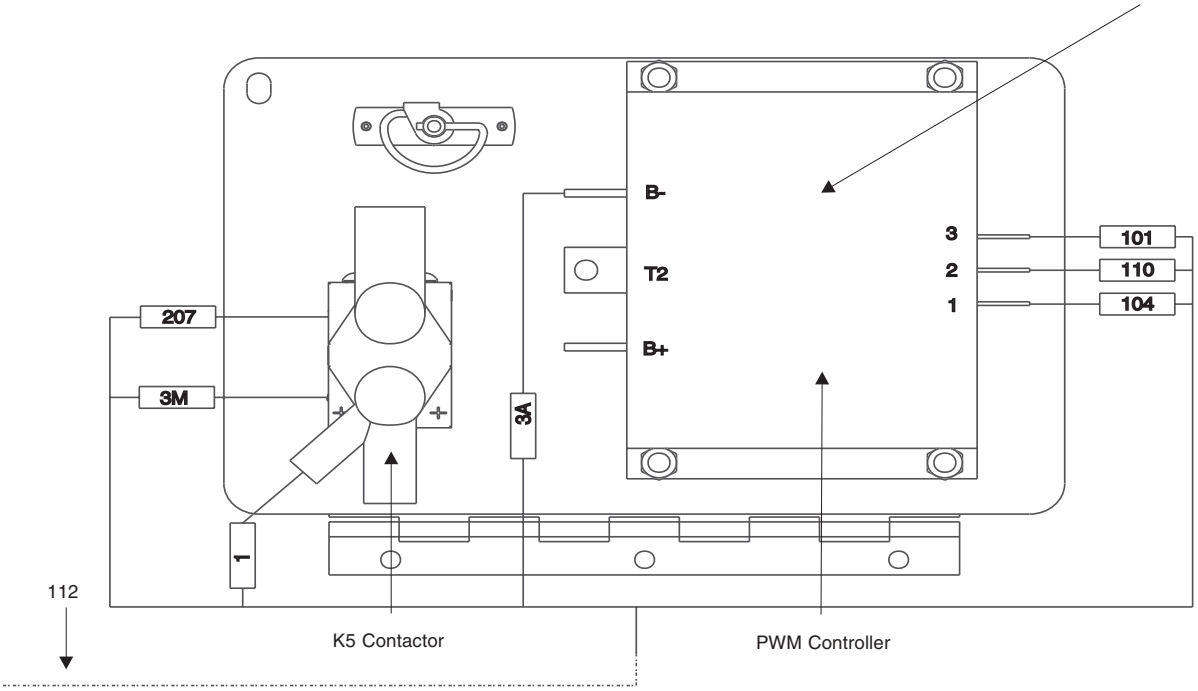


Figure 8.22—Wiring Harness Connections (right)

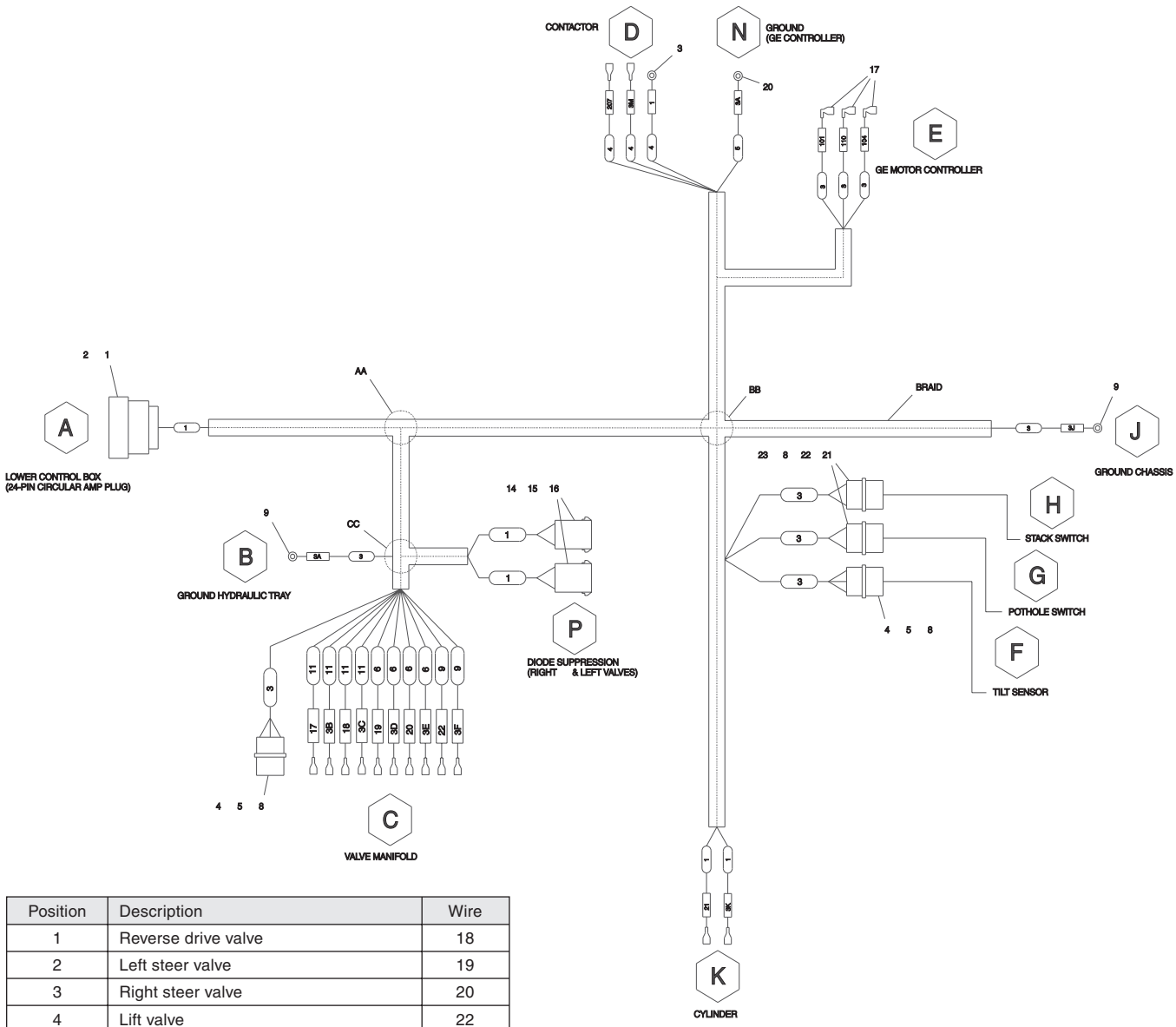


Figure 8.23—Main Harness

Position	Description	Wire
1	Reverse drive valve	18
2	Left steer valve	19
3	Right steer valve	20
4	Lift valve	22
5	From tilt sensor	111
6	Output voltage controller	110
7	From pressure switch	104A
8	From lowering interrupt switch	108
9	Forward drive valve	17
10	Contactor	207
11	From stack switch	106
12	Spare	plug
13	Controller	104
14	Lowering interrupt switch	103A
15	Battery positive	1
16	Spare	plug
17	Pothole stack switch	102
18	Down valve	21
19	Controller signal	101A
20	Spare	plug
21	Spare	plug
22	Pressure switch	100
23	Ground	3
24	Spare	plug

Figure 8.24—Lower Control Box (A)

Pos	Wire	Description
A	100	Pressure switch power
B	104A	From pressure switch
C	3N	Ground

Figure 8.25—Pressure Switch (C)

Pos	Wire	Description
1	3R	Suppression left valve ground
2	219	Suppression left valve

Figure 8.26—Suppression Left (P)

Pos	Wire	Description
1	3S	Suppression right valve ground
2	220	Suppression right valve

Figure 8.27—Suppression Right (P)

Wire	Description	Guage	From Location	Terminal Type	Splice to Wire #	To Location	Terminal Type	Color
1	Battery positive	16	D	3		A	2	Red
3	Control box ground	16	AA		3A	A	2	Black
3A	Hydraulic tray ground	12	N	3		B	9	Black
3B	Forward valve ground	16	CC		3A	C	10	Black
3C	Reverse valve ground	16	CC		3A	C	10	Black
3D	Steer left valve ground	16	CC		3A	C	10	Black
3E	Steer right valve ground	16	CC		3A	C	10	Black
3F	Lift valve ground	16	CC		3A	C	10	Black
3H	Tilt sensor ground	16	BB		3J	F	8	Black
3J	Chassis ground	12	BB		3A	J	9	Black
3K	Down valve ground	16	BB		3J	K	10	Black
3M	Contactor ground	16	BB		3A	D	10	Black
3N	Pressure switch ground	16	CC		3A	C	8	Black
3R	Suppression left valve ground	16	CC		3D	P	14	Black
3S	Suppression right valve ground	16	CC		3E	P	14	Black
17	Forward drive valve	16	A	2		C	10	White
18	Reversedrive valve	16	A	2		C	10	White
19	Left steer valve	16	A	2		C	10	White
20	Right steer valve	16	A	2		C	10	White
21	Down valve	16	A	2		K	10	White
22	Lift valve	16	A	2		C	10	White
100	Pressure switch power	16	A	2		C	8	White
101	Controller signal	16	A	2		E	17	White
102	Pothole power	16	A	2		G	8	White
102A	6' stack power	16	BB		102	H	8	White
103	Lowering interrupt switch power	16	A	2		M	8	White
104	Controller power	16	A	2		E	17	White
104A	From pressure switch	16	C	8		A	2	White
106	From stack switch	16	H	8		A	2	White
108	From lowering interrupt switch	16	M	8		A	2	White
110	Controller output voltage	16	E	17		A	2	White
111	From tilt sensor	16	F	8		A	2	White
112	Pothole to tilt sensor	16	G	8		F	8	White
207	Contactor power	16	A	2		D	10	White
219	Left valve supression	16	CC		19	P	14	White
220	Right valve suppression	16	CC		20	P	14	White

Terminal Type	Part #	Description	Terminal Type	Part #	Description
2	3049976	Amp socket contacts-16	10	3040083	Terminal FEM250FI 16/14
3	3044163	Terminal R312I 16/14	14	3049985	Amp pin contact 20/14 GA
8	3040342	Socket contact-16 Deutsch	17	3040549	Terminal 250FI 90DEG 16/14 GA
9	3044855	Terminal R2501 12/10			

Figure 8.28—Main Harness Wire Routing

Pos	Wire	Description
A	112	Pothole to tilt sensor
B	111	From tilt sensor
C	3H	Ground

Figure 8.29—Tilt Sensor (F)

Pos	Wire	Description
1		Spare
2	102	Pothole power
3	112	Pothole to tilt sensor
4		Spare

Figure 8.30—Pothole Switch (G)

Pos	Wire	Description
1		Spare
2	102A	6' stack power
3	106	From stack switch
4		Spare

Figure 8.31—Stack Switch (H)

Pos	Wire	Description
1	108	From lowering interrupt switch
2	103	Lower interrupt switch power

Figure 8.32—Lowering Interrupt Switch (M)

Wire	Description	From Location	To Location
2	Power	A	B
3P	Ground	A	B
17	Forward drive	A	B
18	Reverse drive	A	B
19	Left steer	A	B
20	Right steer	A	B
222	Platform lift	A	B
101	Output from joystick	A	B
103	Platform down	A	B
114	Return power to lower control box	A	B
121	Potentiometer resistors	A	B
122	Center tap	A	B
Wire guage: 16, Terminal type: 16 Deutsch socket contact (part # 3040342)			

Figure 8.34—Stack Wire Identification

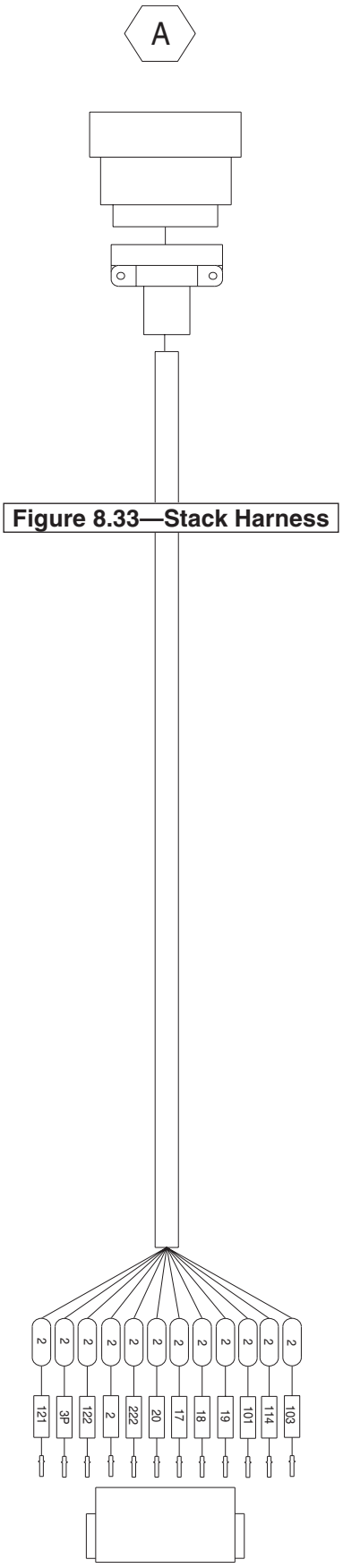


Figure 8.33—Stack Harness

Pos	Wire	Description
A	121	Potentiometer resistors
B	3P	Ground
C	122	Center tap
D	2	Power
E	222	Platform lift
F	20	Right steer
G	17	Forward steer
H	18	Reverse drive
J	19	Left steer
K	101	Output from joystick
L	114	Return power to lower control box
M	103	Platform down
N	Plug	Spare
P	Plug	Spare

Figure 8.35—Location A

Pos	Wire	Description
1	121	Potentiometer resistors
2	3P	Ground
3	122	Center tap
4	2	Power
5	222	Platform lift
6	20	Right steer
7	17	Forward drive
8	18	Drive reverse
9	19	Left steer
10	101	Output from joystick
11	114	Return power to lower control box
12	103	Platform down

Figure 8.36—Location B

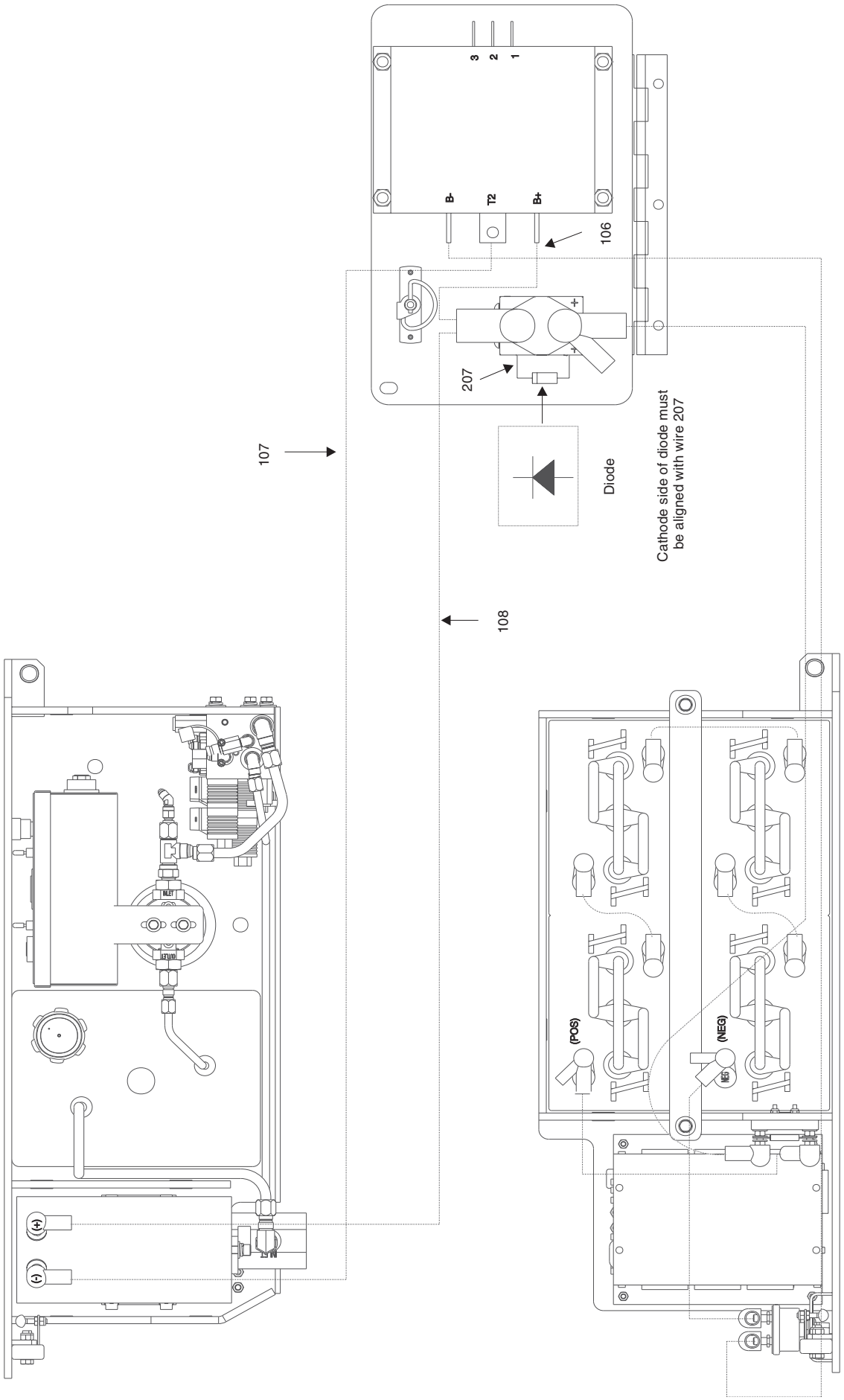


Figure 8.37—Battery Cable Connections

Appendix A. Glossary

aerial platform—a mobile device that has an adjustable position platform, supported from ground level by a structure.

ambient air temperature—the air temperature of the immediate environment.

ammeter—an instrument for measuring the strength of an electric current in amperes.

annual maintenance—the maintenance routine required after every 500 hours of operation.

authorized personnel—personnel approved as assigned to perform specific duties at a specific location.

base—the relevant contact points of the aerial platform that form the stability support (e.g., wheels, casters, outriggers, stabilizers).

battery tray—a swing-out compartment that holds the batteries and the battery charger.

center of gravity—the point in the aerial platform around which its weight is evenly balanced.

chassis—the integral part of the aerial platform that provides mobility and support for the scissors structure.

electrolyte—an electricity conducting liquid covering the cells in a lead-acid battery, usually distilled water.

fall restraint—a system that is used while working on a boom lift within the boundaries of platform guardrails to provide restraint from being projected upward from the platform. This system includes a harness or belt, lanyard, and a lanyard anchor. Although federal regulations, OSHA, ANSI, and Snorkel do not require the use of fall protection beyond the platform guardrails on scissors lift aerial platforms, local, state, or employer rules may require their use.

floor or ground pressure—the maximum pressure, expressed in pounds per square inch, a single wheel concentrates on the floor or ground.

free-wheeling valve—a needle valve that when adjusted open allows hydraulic fluid to flow through the wheel drive motors. This allows the aerial platform to be pushed or towed without damage to the drive motors.

frequent maintenance—the maintenance routine required after 90 days or 150 hours of operation.

gradeability—the maximum slope that the aerial platform is capable of travel.

ground fault circuit interrupter (GFCI)—a fast-acting circuit breaker that opens to stop electrical circuit flow if it senses a very small current leakage to ground. The GFCI is used to protect personnel against a potential shock hazard from defective electrical tools or wiring.

guardrail system—a vertical barrier around the platform to prevent personnel from falling.

hazardous location—any location that contains, or has the potential to contain, an explosive or flammable atmosphere as defined by ANSI/NFPA 505.

hydraulic tray—a swing-out compartment that holds the electrical panel for the lower controls, the hydraulic directional control valve, the free-wheeling valve, the pump, and the hydraulic fluid filter.

king pin—a spindle that protrudes up from the frame that provides a pivot point for the steering assembly.

lanyard anchor—a tie-down loop securely fastened to the base of the work platform, used to anchor a fall restraint harness.

level sensor—an instrument that measures the degree of variation from perfect horizontal, it contains an interlock that will prevent the machine from operating at a dangerous angle.

lower controls—the controls located at ground level for operating some or all of the functions of the aerial platform.

manufacturer—a person or entity who makes, builds, or produces an aerial platform.

maximum travel height—the maximum platform height or the most adverse configuration(s) with respect to stability in which travel is permitted by the manufacturer.

maximum wheel load—the load or weight that can be transmitted through a single wheel to the floor or ground.

Minimum Safe Approach Distance—the minimum safe distance that electrical conductors may be approached when using the aerial platform. Also called M.S.A.D.

operation—the performance of any aerial platform functions within the scope of its specifications and in accordance with the manufacturer's instructions, the users work rules, and all applicable governmental regulations.

operator—a qualified person who controls the movement of an aerial platform.

personal fall arrest system—a fall protection system that is used while working on an unprotected edge (such as a roof top with no guardrail). This system includes a harness, lanyard or other connecting device, a fall arrester, an energy absorber or decelerator, an anchorage connector, and a secure anchorage such as a building beam, girders or columns. An aerial platform is not a fall arrest anchorage.

platform—the portion of an aerial platform intended to be occupied by personnel with their necessary tools and materials.

platform height—the vertical distance measured from the floor of the platform to the surface upon which the chassis is being supported.

pothole protection—a mechanical tip-over prevention system consisting of skids located along the bottom of the right and left sides which lower as the platform is raised.

pothole protection interlock—a safety feature that sounds an alarm and automatically halts the platform raise function if the pothole protection is prevented from lowering properly.

prestart inspection—a safety inspection routine required prior to daily operation.

qualified person —a person, who by reason of knowledge, experience, or training, is familiar with the operation to be performed and the hazards involved.

rated work load—the designed carrying capacity of the aerial platform as specified by the manufacturer.

safety prop—a heavy-duty bar to be lowered and secured into position preventing the scissors from collapsing, a safety feature designed to prevent injury.

slide block—block made of low friction UHMW polyethylene attached to the scissors at the point of support for the platform and chassis. They move within a channel allowing the scissors to open and extend.

stow—to place a component, such as the platform, in its rest position.

turning radius—the radius of the circle created by the wheel during a 360° turn with the steering turned to maximum; inside radius: the wheel closest to the center, outside radius: the wheel farthest from the center.

unrestricted rated work load—the maximum designed carrying capacity of the aerial platform allowed by the manufacturer in all operating configurations.

upper controls—the controls located on or beside the platform used for operating some or all of the functions of the aerial platform.

wheelbase—the distance from the center of the rear wheel to the center of the front wheel.

working height—platform height plus six feet.

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Limited Warranty

Snorkel warrants each new machine manufactured and sold by it to be free from defects in material and workmanship for a period of one (1) year from date of delivery to a Customer or for one year after the machine has been placed in first service in a Dealer rental fleet, whichever comes first. Any part or parts which, upon examination by the Snorkel Service Department, are found to be defective, will be replaced or repaired, at the sole discretion of Snorkel, through its local Authorized Dealer at no charge.

Snorkel further warrants the structural components; specifically, the mainframe chassis, turntable, booms and scissor arms, of each new machine manufactured by it to be free from defects in material and workmanship for an additional period of four (4) years. Any such part or parts which, upon examination by the Snorkel Service Department, are found to be defective will be replaced or repaired by Snorkel through its local Authorized Dealer at no charge; however, any labor charges incurred as a result of such replacement or repair will be the responsibility of the Customer or Dealer.

The Snorkel Service Department must be notified within forty-eight (48) hours of any possible warranty situation during the applicable warranty period. Personnel performing warranty repair or replacement must obtain specific approval by Snorkel Service Department prior to performing any warranty repair or replacement.

Customer and Dealer shall not be entitled to the benefits of this warranty and Snorkel shall have no obligations hereunder unless the “Pre-Delivery and Inspection Report” has been properly completed and returned to the Snorkel Service Department within ten (10) days after delivery of the Snorkel product to Customer or Dealer’s rental fleet. Snorkel must be notified, in writing, within ten (10) days, of any machine sold to a Customer from a Dealer’s rental fleet during the warranty period.

At the direction of the Snorkel Service Department, any component part(s) of Snorkel products to be replaced or repaired under this warranty program must be returned freight prepaid to the Snorkel Service Department for inspection. All warranty replacement parts will be shipped freight prepaid (standard ground) from the Snorkel Service Department or from Snorkel’s Vendor to Dealer or Customer.

REPLACEMENT PARTS WARRANTY

Any replacement or service part made or sold by Snorkel is not subject to the preceding **Limited Warranty** beyond the normal warranty period of the machine upon which the part was installed.

THIS WARRANTY EXCLUDES AND SNORKEL DOES NOT WARRANT:

1. Engines, motors, tires and batteries which are manufactured by suppliers to Snorkel, who furnish their own warranty. Snorkel will, however, to the extent permitted, pass through any such warranty protection to the Customer or Dealer.
2. Any Snorkel product which has been modified or altered outside Snorkel’s factory without Snorkel’s written approval, if such modification or alteration, in the sole judgment of Snorkel’s Engineering and/or Service Departments, adversely affects the stability, reliability or service life of the Snorkel product or any component thereof.
3. Any Snorkel product which has been subject to misuse, improper maintenance or accident. “Misuse” includes but is not limited to operation beyond the factory-rated load capacity and speeds. “Improper maintenance” includes but is not limited to failure to follow the recommendations contained in the Snorkel Operation, Maintenance, Repair Parts Manuals. Snorkel is not responsible for normal maintenance, service adjustments and replacements, including but not limited to hydraulic fluid, filters and lubrication.
4. Normal wear of any Snorkel component part(s). Normal wear of component parts may vary with the type application or type of environment in which the machine may be used; such as, but not limited to sandblasting applications.
5. Any Snorkel product that has come in direct contact with any chemical or abrasive material.
6. Incidental or consequential expenses, losses, or damages related to any part or equipment failure, including but not limited to freight cost to transport the machine to a repair facility, downtime of the machine, lost time for workers, lost orders, lost rental revenue, lost profits or increased cost.

This warranty is expressly in lieu of all other warranties, representations or liabilities of Snorkel, either expressed or implied, unless otherwise amended in writing by Snorkel’s President, Vice President-Engineering, Vice President-Sales or Vice President-Marketing.

SNORKEL MAKES NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION OF THIS LIMITED WARRANTY. SNORKEL MAKES NO IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE AND DISCLAIMS ALL LIABILITY FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO INJURY TO PERSONS OR PROPERTY.

The Customer shall make all warranty claims through its local Authorized Dealer and should contact the Dealer from whom the Snorkel product was purchased for warranty service. Or, if unable to contact the Dealer, contact the Snorkel Service Department for further assistance.

Effective July 1995

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